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IN THE

Supreme Court of The United States

OCTOBER TERM, 1979

No. .....

CATHODIC PROTECTION SERVICE, A PARTNERSHIP,

Petitioner,

v.

AMERICAN SMELTING AND REFINING COMPANY (ASARCO) AND WAYNE BROYLES ENGINEERING COMPANY (BROYLES),

Respondents.

PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

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OPINIONS AND RECORD BELOW

The opinion of the Court of Appeals for the Fifth Circuit (Appendix B-1 to B-54) is reported at 594 F.2d 499. The relevant opinions and judgment of the District Court are not officially reported but appear herein in Appendix A-1 to A-39 and G-1 to G-4. References in this Petition to "TR" are references to the transcript of testimony and other proceedings in the Trial Court. References to "Appendix" are to the eight appendices to this Petition (Identified as A-H).

JURISDICTION

Petitioner's timely Motion for Rehearing was denied by the Court of Appeals on July 2, 1979 (Appendix C). The jurisdiction of this Court is founded on 28 U.S.C. § 1254(1).

QUESTION PRESENTED

Did the Court of Appeals correctly hold that the patent issued for the Davis/Doremus apparatus was invalid for failure to meet the statutory requirement of non-obviousness?

STATUTE TO BE CONSTRUED

"A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made. July 19, 1952, c. 950, § 1, 66 Stat. 798." 35 U.S.C. § 103.

SUMMARY OF ESSENTIAL REASONS WHY THIS PETITION SHOULD BE GRANTED

This case (when combined with many similar lower court opinions) reveals that many Courts of Appeals are not consistently, faithfully applying the intent of Congress as expressed in the Patent Act of 1952. The stabilizing effect sought by Congress and by this Honorable Court in *Graham* v. *John Deere Co.*, 383 U.S. 1, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966) has not been achieved.

The various Courts of Appeals, and individual panels within the same court, are applying totally different and

inconsistent methods for deciding questions of "nonobviousness". The Court of Customs & Patent Appeals (hereinafter CCPA) applies an internally consistent method in deciding "nonobviousness" questions, but that method is inconsistent with the last two decisions of this Honorable Court and the methods often employed by many of the Courts of Appeals.[1]

The case at bar was erroneously decided by the Court of Appeals because of unnecessary and widely prevailing confusion in interpreting 35 U.S.C. § 103.

STATEMENT OF FACTS

Shortly after World War II, technology was developed to guard offshore pipelines from corrosion by application of well-known principles of cathodic protection. (TR. 182).

The basic principle[2] of cathodic protection has been well-known since 1848 (TR. 201) and in use in the land pipeline industry since at least 1930. (TR. 201). Cathodic protection devices used upon onshore pipelines are not effective on lengthy, often isolated offshore pipelines. (TR. 182-186).

Respondents ASARCO and BROYLES initially marketed cathodic protection devices for offshore pipelines by creating a "bracelet" of anodic material (almost always zinc) to encircle the pipeline. ASARCO is one of the world's largest — if not the largest — suppliers of zinc, and for more than a decade had a total monopoly of cathodic bracelets for offshore pipelines. (TR. 195).

Respondents distributed a publication identified here as ASARCO Bulletin 191 describing their bracelet anode, herein sometimes referred to as the Bulletin 191 bracelet anode, or, in short the ASARCO bracelet. (Trial Court Exhibit P-18 — Appendix D-1); (TR. 194). After Petitioner had obtained a patent for its apparatus (hereinafter the

"Davis/Doremus apparatus"), ASARCO and BROYLES copied the Davis/Doremus apparatus and attempted to patent their copy. (TR. 431-432, 667). The Patent Office then held that ASARCO's copy was anticipated by the Davis/Doremus apparatus. (TR. 677).

The original ASARCO 191 bracelet anode was a primitive, clumsy assembly — expensive and extremely difficult to fabricate and apply to the pipeline. (TR. 210-231 and see pictures at Appendix D-2, 01-3). Its chief virtue, from ASARCO's point of view, was that it provided a framework for placing large quantities of zinc around offshore pipelines. Once laboriously and expensively installed, it performed its essential function acceptably. (TR. 217-231).

Petitioner, Cathodic Protection Service (hereinafter "CPS"), at all material times was a partnership composed of two brothers — Ed and Gordon Doremus. (TR 178)[3]. Gordon Doremus was technically educated (TR. 176); he performed and later supervised the technical aspects of CPS' business, which was the engineering, sale, installation and servicing of cathodic protection systems. (TR. 207). CPS' major customers have been major pipeline transmission companies, although CPS has during its history furnished a wide variety of cathodic protection services for many industrial customers. (TR. 178).

For three years — from 1965 to 1968 — Gordon Doremus and Jack Davis (the co-inventors of the Davis/Doremus apparatus) struggled with the problems associated with the ASARCO bracelet. (TR. 235, *et seq.*, 580). ASARCO had several distributors including CPS, which sold cathodic protection systems to offshore pipelines and in doing so was charged with the responsibility of assembling and servicing the ASARCO bracelets. (TR. 181). The ASARCO bracelet had three essential weaknesses, to wi

(1) It was extremely expensive to assemble — requiring multiple hand operations at several different assembly points. (TR. 217).

(2) More significant, it was easily deformed during shipping and handling — causing customer frustration, expense and bitter customer complaints; (TR. 217, 575-576 — See Trial Court Exhibit PX1-F, Appendix D-2 herein).

CPS, as a service organization, was most eager to minimize customer frustration. (TR. 227, *et seq.*).

(3) Least significant, the ASARCO device was arguably inefficient in that it may have required some of the corrosion protective current to protect the device itself. (TR. 226).

Davis and Doremus, whose credibility was established (as is evidenced by the Trial Court's findings) gave almost daily attention for three years to the task of solving the problems inherent in the ASARCO bracelet. (TR 232, 235-243). Their initial thrust was to make the steel bands on each end of the "bracelet" heavier. (TR. 232). This effort made the "bracelet" more cumbersome, expensive and difficult to apply and did not solve the deformation problems. Finally, after considerable thought, experimentation, study and inquiry concerning fabrication feasibility Davis/Doremus conceived the concept of the Davis/Doremus apparatus. (See preferred embodiment in Appendix D-3 herein.)

The Davis/Doremus apparatus (see picture at D3-1) is innovative over the ASARCO bracelet in the following respects:

(1) The clumsy, external steel bands, which were one of the essential elements of the ASARCO device, are completely eliminated (TR. 243-247, 384, *et seq.*);

(2) The steel core is, for the first time in a device of this nature, placed in a circumferential rather than

a longitudinal direction relative to the pipe's axis. (TR. 243-247, 384, *et seq.*); and

(3) The multiple segments of anodic material characteristic of the ASARCO bracelet — each with its own core — are replaced (in the preferred embodiment) by two semi-cylindrical segments of anodic material which embrace the pipe rather than surround it. (TR. 243-247, 384, *et seq.*).

The Davis/Doremus apparatus may appear, in hindsight, to be simple. The Davis/Doremus apparatus, instead of being a mere "combination of old elements"[4] is actually an innovation which totally eliminates the clumsy, easily deformed external bands while retaining their function. A careful Trial Court and a presumably expert Patent Examiner, in two independent examinations at the Patent Office, found this useful innovation unobvious.

The Davis/Doremus device was designed to allow the user to install the apparatus in a unique environment. The pipe to be protected is initially coated with protective material, the cathodic protection device is then placed on the pipe outside the protective coating. The protective coating and the device are then encased in concrete, placed aboard a barge, rolled into the ocean and ultimately placed in a trench on the bottom of the sea. The designers were required to so design their apparatus to fit into and be readily placed into and be compatible with this unique environment and the pipe-laying equipment used in this environment. (TR. 154-155, 161-164). The device must, in contrast to land application, protect the pipeline for forty years without maintenance. (TR. 185 *et seq.*).

Davis/Doremus enlisted the assistance of patent counsel and applied for a patent. After debate with the Patent Examiner and initial rejection, the patent was officially issued. It is noteworthy that the Patent Examiner

initially did not understand the essence of the Davis/Doremus apparatus and erroneously believed that its novelty simply involved the casting of the individual, segment anodes in semi-cylindrical form. (TR. 272).

As this Honorable Court knows, there is, and can be, no ironclad, always applicable, easily applied formula for determining what "prior art" should be submitted to the Patent Examiner, but here the careful Trial Court held (we contend properly) that the most pertinent prior art had been submitted to the Patent Examiner. (Appendix A-14, *et seq.*). For purposes of completeness, diagrams or publications representing the bulk of the actual or alleged prior art are set forth in Appendix D.[5]

CPS incurred ASARCO's wrath when it "bolted from the family", began to cast its own anodes, and fabricated its own bracelets. (TR 639, *et seq.* Trial Court Ex. 23C, Appendix E). Ultimately CPS penetrated even more deeply into ASARCO's monopoly when it designed and obtained patent protection for the Davis/Doremus apparatus.

When the patented device was offered to the industry it gained immediate, enthusiastic acceptance. (TR. 433-434; 590). There is no evidence that this commercial success was merely the result of extensive advertising. Success was the result of technological merit — not advertising. ASARCO, very concerned about the competitive edge which CPS had obtained through Davis/Doremus ingenuity and enterprise, recorded its concern as follows:

> "As I indicated on the phone several weeks ago, we now have competition on our bracelet anodes, which are used to protect offshore pipelines. We are convinced we must redesign our anodes away from individual segments which are subsequently assembled by welding to steel rings.
>
> The Houston Plant requires know-how in the design and construction of true permanent molds, and we

are requesting that you do everything you can to assist them in this endeavor.

• • •

Obviously, we have a good deal of experimentation to do to determine the most practical internal core arrangement, but I believe that a good starting point is to use relatively light gauge steel on the interior portions, welded to heavier gauge material that extends outside of the anodes. Assembly is, of course, by welding. Time is a decided factor at this point, and we would appreciate receiving copies of any information forwarded tc Houston."

(See Trial Court Plaintiff Exhibit 23-B Memorandum from G. W. Kurr of ASARCO to D. Lavelle of ASARCO Research.) (TR. 650, 652, 658).

ASARCO's concern about competition is understandable. ASARCO had previously had no competition; it had been the only supplier of cathodic protection bracelets for offshore pipelines. (TR. 195).

ASARCO's concern (adequately demonstrated from the quotations above and the Trial Court's findings) motivated ASARCO to initiate a deliberate program to copy the Davis/Doremus apparatus. ASARCO dispatched agents to study and secretly photograph the Davis/Doremus apparatus while the CPS patent application was still pending. (TR. 639, *et seq.*, 650, Trial Court Ex. 23-A).

ASARCO's technical and research staff had considerable difficulty determining how the Davis/Doremus device was made and how the Davis/Doremus device could be effectively copied. (See Trial Court Exhibits PX 23A, 23B, 23K, 23L, 23M, 23C and 23E.)

In reaction to the competitive advantage which Davis/Doremus' inventiveness had produced, ASARCO engaged in the following conduct:

"6. The conduct of ASARCO and BROYLES evidences a program to eliminate CPS as a potential competitor by:

(1) Knowingly and willfully infringing plaintiffs' reissue patent;

(2) ASARCO's offering 'advantageous' prices for the old ASARCO Bulletin 191 bracelet anodes to Broyles and to other competitors of CPS;

(3) ASARCO's refusing to sell zinc to CPS for the making of its patented anodes; and

(4) ASARCO's offering to BROYLES a blanket 'hold harmless' indemnity against liabilities arising out of BROYLES' infringement.''

See Paragraph 6 of Trial Court Judgment entered January 12, 1976 — (TR. 65, Appendix G).

CPS discovered ASARCO's efforts to copy the Davis/Doremus apparatus (TR. 390), employed new counsel because their former counsel was retiring, filed suit and made application for a reissue patent under 35 U.S.C. § 251. (TR. 402). Again after considerable debate with and full explanation to the Patent Examiner and considerable study of the reissue application by the Examiner, the reissue patent (which is the subject matter of this case) was officially issued.

Respondents copied the Davis/Doremus apparatus covered by the reissue patent; their copy is an infringement. The Trial Court has so held and this finding is entitled to the presumption of correctness mandated by Rule 52(a), FRCP.

The case was initially tried before the Honorable Carl Bue, United States District Judge for the Southern District of Texas. Judge Bue, in his characteristically careful and meticulous manner, entered independently-drafted

very detailed findings of fact and conclusions of law (A-1 to A-39), holding the reissue patent on the Davis/Doremus apparatus a pioneer patent, valid and infringed. The Court of Appeals held (APP. B-1 to B-54) that the patented device as a matter of law did not meet the statutory requirement of non-obviousness, declared the reissue patent invalid.

REASONS FOR GRANTING THE WRIT

This case, viewed in isolation, is important only to the parties; when viewed from a broader perspective, however, it is an outstanding example of the confusion in the lower courts regarding the fundamental concept of "non-obviousness", which is the cornerstone of the patent law. This Honorable Court's opinions since 1952 have not yet created the "stabilizing effect" which Congress intended to achieve in the Patent Act of 1952, and which this Honorable Court sought in the *Graham Trilogy*.

The Patent Act of 1952 (35 United States Code § 101, *et seq.*) was drafted because of widespread belief (which received Congressional sanction) that the Federal judiciary was invalidating an excessive number of meritorious patents and failing to provide the patent system with the stability, consistency and predictability desirable in any governmental or commercial activity, particularly any governmental activity dealing with the title to significant industrial property rights.[6]

It has been statistically demonstrated that in the seventeen years after the enactment of the 1952 Patent Act some Courts of Appeals declared invalid 75% to 86% of all patents presented to those courts for analysis and judgment.[7]

The undersigned counsel, in prepartion of this Petition, have surveyed all patent cases considered by the Courts of Appeals from 1969 to 1979 and have determined from the reported cases decided during that decade a patent presented to a Court of Appeals was in just as much jeopardy as during the seventeen years after the enactment of the 1952 Patent statute. (See Appendix F.)

In each of these cases in which a Court of Appeals has invalidated a patent, a Patent Examiner had previously held that the statutory requirements of patentability had been satisfied. In many of the cases, as in the case at bar, both a Patent Examiner and a Trial Court (who heard the witnesses and observed the witnesses describing and manipulating the devices in question) had concluded that the challenged patent was valid. In the case at bar the claims were twice fully prosecuted in the Patent and Trademark Office and upheld by a careful, skilled Trial Court.

Justice Jackson (1949) has in substance observed (describing the conditions of his time) that the only valid patent was one which the Federal Appellate Judiciary had not gotten its hands on.[8] While this observation may appear extreme, the statistics discussed just above lend considerable support to Justice Jackson's view and suggest that this observation is even truer today than when made.

Surely Congress in 1952 did not contemplate that in many Courts of Appeals over 80% of the patents whose validity was contested would be declared invalid. This lack of stability and predictability (and the decisions which have allegedly created this stability) have been authoritatively criticized.[9]

Some observers believe that the Federal judiciary — particularly at the appellate level — is deeply, philosophically hostile to the patent system, and that this largely

visceral philosophic animosity results in the statistics set forth above.[10] If this is so, this Petition and all similar petitions, must inevitably be forthwith summarily rejected; but, surely there is some more rational and flattering explanation (more consistent with the doctrine of separation of powers) for the "notorious difference"[11] between the manner in which the Patent Examiners, District Courts and the Courts of Appeals apply the Congressionally mandated tests of patentability.

Petitioner respectfully submits that a large portion of the "notorious difference" between the way Patent Examiners and lower Courts apply the patent law rests in certain weaknesses which are now (in the light of thirteen years of hindsight) readily discoverable in the language employed by this Honorable Court initially in 1966 in the *Graham Trilogy*. This Honorable Court there described, in part, a systematic, sensible method by which lower Courts and Patent Examiners could make determinations on questions of nonobviousness. This Honorable Court there said, in part:

> "Under 103 the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of skill and the pertinent art resolved." 383 U.S. at 17.

This method of analysis, as far as it went, is sensible, helpful and non-controversial.[12] The portion of the *Graham* opinion, however, which has (in conjunction with the subsequent opinions of this Honorable Court) caused difficulty, uncertainty and instability (e.g., the case at bar) is that language in which the Court says:

> "Such secondary considerations as commercial success, unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy." 383 U.S. at 17, 18.

What did the Court mean by "might", by "may"? When is so-called "secondary evidence" significant? When, if at all, should the so-called "secondary evidence" be given serious or controlling weight by the Trial Court or Patent Examiner? Why did the Court call this type of evidence "secondary evidence"? Why is it to be regarded as "secondary"? What really does "secondary" in this context mean? What does "etc." mean? If the secondary considerations are indeed "secondary evidence" what is or should be the primary evidence? Why should the question of "unobviousness" be treated any differently from other legal questions or questions of mixed fact and law?

A Trial Court, making a determination of "unobviousness", is engaged in an inquiry basically similar to an inquiry relating to a question of negligence, or product defect or professional malpractice or market value. In a negligence case, the finder of fact determines what a hypothetical person of ordinary prudence would have done under the same or similar circumstances and thus establishes a standard to judge conduct. In a case of an alleged product defect, the finder of fact determines if the challenged product was more dangerous than would have been contemplated by a hypothetical ordinary user or consumer. In professional malpractice litigation, the finder of fact determines the level of skill and competence of the ordinary prudent practitioner and determines if the conduct of the defendant was consistent with that standard. In controversies hinging upon the determination of "market value" the analysis is similar. The finder of fact constructs a hypothetical seller who wishes to but is not compelled to sell and a hypothetical buyer who wishes to but is not compelled to buy and then determines what bargain these hypo-

thetical persons would strike for the property condemned by the state or destroyed by the defendant's fault.

Conceptually, an unobviousness inquiry should be identical to the inquiries described in the above paragraphs. The Patent Examiner or Trial Court is to determine the level of skill in the art and intellectually construct a hypothetical person of ordinary skill in the art. The inquiry then becomes whether the device in question, for which a patent is sought, or has been granted, would in the light of the pertinent prior art be obvious to a person of ordinary skill in the art. Patent law, in determinating obviousness, need not be an arcane, hypertechnical inquiry which some have described as the metaphysics of the law. On the contrary, with proper guidance from this Honorable Court, determinations of unobviousness can be made with the same degree of reliability and stability found in negligence, product defect, seaworthiness, crashworthiness, professional malpractice and eminent domain cases.[13]

ANALYSIS OF "SECONDARY EVIDENCE"

One difficulty — and most probably the difficulty which resulted in the erroneous Court of Appeals' decision in the case at bar — is that the *Graham Trilogy, supra* (and the subsequent decisions of this Honorable Court)[14] creates needless uncertainty as to how the Patent Examiner or lower court is to approach and analyze the issue of obviousness — particularly in connection with how to deal with the so-called "secondary evidence".[15]

Many of the Courts of Appeal — and apparently the Fifth Circuit panel which decided this case is one of them — construe the *Graham* language quoted verbatim above, page 12, to mean that the Patent Examiner and the Trial Judge should simply determine the hypothetical person of ordinary skill in the art, understand and study

the prior art and then primarily make an unguided, visceral, judgmental decision as to whether the device at issue is unobvious when compared to the prior art. The "secondary evidence", according to this method, is to be considered, if at all, only in a close case. It is submitted that this approach is rooted in hindsight, instead of the statutorily mandated "time the invention was made". (35 U.S.C. § 103).√CPS will, in an admitted exercise of counsel's function as an advocate, refer to the approach described in this paragraph [and employed (we respectfully assert) by the Court of Appeals in the case at bar] as the "visceral reaction method".

The "visceral reaction method" of deciding questions of unobviousness is arguably consistent with the *Graham Trilogy, supra,* language and with this Honorable Court's handling of *Sakraida* v. *Ag Pro and Black-Rock.* (See FN 14). The language of the *Graham Trilogy* by referring to certain categories of evidence as "secondary" and stating that "secondary" evidence "may" or "might" be relevant has given this Court's apparent blessing to the "visceral reaction method".

The United States Court of Custom and Patent Appeals (hereinafter "CCPA") and some of the Courts of Appeals have (we submit correctly) refused to follow the "visceral reaction method" adopted by many other Courts of Appeals and have instead properly (we submit) held that issues of unobviousness should be decided on the same basis as other comparable issues — that is, by considering all relevant evidence, including the so-called "secondary considerations", and making the decision on the basis of a judicious and thorough consideration of all the evidence. The approach described in this paragraph will be designated as the "Learned Hand/CCPA approach". Judge Learned Hand, in cases which intervene between the 1952 Patent

Act and the decision of this Honorable Court in the *Graham Trilogy* applied this approach in his normally perceptive and lucid manner the "Learned Hand/CCPA method" considers all of the evidence (including the so-called "secondary evidence"), gives the evidence such weight as seems appropriate and then decides the question of "unobviousness" based on the entirety of the relevant evidence.

The Courts of Appeals are applying inconsistent methods in making determinations of patentability under Section 103. The contrasting analytical approaches can be illustrated by comparing recent cases from the 7th and 9th Circuits.

The 7th Circuit opinion, *Republic Industries Inc.* v. *Schlage Lock Company,* 592 F.2d, 963 200 U.S.P.Q. 769 (7th Cir., 1979) is an excellent example of the "visceral reaction" method which refuses to give any weight to so-called "secondary considerations". The court's attitude and approach is epitomized in the following language:

> "Republic strenuously argues that we should weigh such secondary considerations as commercial success, long felt need and failure of others . . . we decline this invitation. While such secondary consideration, may be 'indicia of obviousness on non-obviousness' . . . 'those matters without invention will not make patentability' *Anderson's Black-Rock Inc.* v. *Pavement Salvage Co.,* 396 U.S. 57, 61 (1969). Only in a close case in which application of the primary criteria of non-obviousness under § 103 does not produce a firm conclusion, can these secondary considerations be used to 'tip the scales in favor of patentability' . . . because we hold that the claims made here are clearly obvious under § 103, we deem it unnecessary to examine these secondary considerations."

Contrast this case with the approach of a panel of the 9th Circuit as demonstrated in *Santa Fe-Pomery, Inc.* v. *P & Z Company, Inc.,* 569 F.2d 1084, 197 U.S.P.Q. 449 (9th Cir. 1978).

The 9th Circuit panel basically adopted the method advocated by Judge Learned Hand in *Reiner* v. *I. Leon Co.,* 285 F.2d 501-504 128 U.S.P.Q. 25 (2nd Cir. 1960) in which Judge Hand pointed out that analysis of the so-called "secondary evidence" is important and essential because secondary evidence is "more susceptible of judicial treatment than are the highly technical facts often present in patent litigation".

The Analysis of the 9th Circuit, diametrically opposed to that of the 7th, is epitomized by the following language:

> "In *Graham, supra,* the Supreme Court made it clear that courts may properly infer non-obviousness from evidence of long felt but unsolved needs, failures of others, and subsequent success and acceptance. 383 U.S. at 17, 18, 86 S.Ct. 708. Citing Judge Hand's opinion in *Reiner,* the court stated that these 'subtests' are 'more susceptible of judicial treatment than are the highly technical facts often present in patent litigation. Id. at 36, 86 S.Ct. at 703. These factors aid the judiciary and prevent it from 'slipping into use of hindsight'. Id.
>
> This Court has held that a patent will not be invalidated simply because 'it embodies a solution which seems simple and obvious with benefit of hindsight'. *Saf-Guard Products,* 523 F.2d at 1272. 'When the evidence shows that several others in the art have attempted to solve the same problem and have not arrived at the solution claimed by the patent in suit, the statutory presumption of validity is substantially strengthened'. *Reeves Instrument Corp.,* 444 F.2d at 272. *Acceptance by the industry and commercial success are factors to be given weight."* (Emphasis added.)

Obviously the 7th Circuit adopts the approach which petitioner here, in an admitted exercise of advocacy, designates the "visceral reaction approach". The 9th Circuit

adopts and employs basically the "Learned Hand/CCPA approach".

Another excellent example of the visceral reaction approach is found in the recent 7th Circuit case, *Lee Blacksmith Inc.* v. *Lindsay Brothers, Inc.,* Case No. 79-1038, August 21, 1979 (Slip Opinion attached as Appendix H):

> "In its findings the district court stated that Lindsay did not offer 'evidence of any kind on the level of ordinary skill at any time in any art of farm earth-working equipment.' The district court then concluded that because Lindsay had failed to establish evidence on one of the factual inquiries as required by *Graham,* the defendant had not overcome the presumption of validity. The district court's conclusion would be correct if *Graham* required that in every case the level of skill in the pertinent art must be resolved. This reading of *Graham* is overbroad.
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> • • •
>
> The gist of our holding in that [*Research Corp.* v. *Nasco Industries, Inc.*] case is that if the differences between the patent in suit and the prior art are such that the subject matter as a whole is obvious to a layman, a determination of the level of skill on the basis of expert testimony in the pertinent art would be useless. What is obvious to a layman would certainly be obvious to one skilled in the art to which the subject matter pertains." — Appendix H at 4-5.

The vigorous dissent of Judge Pell is strong argument in support of clarification of the role of "secondary considerations" and in support of review by this Honorable Court in the case at hand:

> "In the majority opinion the matter of imitations is swept under the rug along with commercial success and unexpected and beneficial results. Aspects such as these are characterized in numerous judicial opinions as "secondary considerations." The majority opinion is breaking no new ground in adopting this characterization. It does appear to me that in relegating some of these aspects, which perhaps are secondary in time at least, the courts have minimized their probative value reflecting upon whether there is obviousness. I must concede that some of the trappings which have been judicially developed on the "secondary considerations" syndrone are probably so firmly entrenched that a realistic reevaluation can now only be forthcoming from the Supreme Court." Appendix H at 10.

Example of cases which have applied the "visceral reaction approach" are:

Reinke Manufacturing, Inc. v. Sidney Manufacturing Corp., ... F.2d ...., 201 U.S.P.Q. 344 (8th Cir. 1979);

Lucerne Products Inc. v. Cutler-Hanover, Inc. 568 F.2d 784, 195 U.S.P.Q. 472 (6th Cir. 1977);

Systematic Tool & Machine Co. v. Walter Kidde & Co., 555 F.2d 342, 193 U.S.P.Q. 587 (3d Cir. 1977);

Parker v. Motorola, Inc., 524 F.2d 518, 188 U.S.P.Q. 225 (5th Cir. 1975);

Airlite Plastics Co. v. Plastilite Corp., 526 F.2d 1078, 189 U.S.P.Q. 327 (8th Cir. 1975).

Examples of cases applying the Learned Hand/CCPA approach:

Forbor Design Corp. v. Raytheon Co., 532 F.2d 758, 190 U.S.P.Q. 49 (1st Cir. 1976).

Photo Electronics Corp. v. England, et al. 581 F.2d 772, 199 U.S.P.Q. 710 (9th Cir. 1978).

U.S. Philips Corp. v. National Micronetrics, Inc., 550 F.2d 716, 193, U.S.P.Q. 65 (2d Cir. 1977).

Tights, Inc. v. Acme-McCrary Corporation, 541 F.2d 1047, 191 U.S.P.Q. 305 (4th Cir. 1976).

Plantronics, Inc. v. Roanwell Corporation, 403 F.Supp. 138 (SDNY 1975), aff. per curiam 535 F.2d 1397 192 U.S.P.Q. 67 (2d Cir. 1976); cert. denied sub nom. Roanwell Corporation v. Plantronics, Inc. 429 U.S. 1004, 97 S.Ct. 538, 50 L.Ed. 2d 617 (1976).

One court whose approach has recently been consistent is CCPA. Its approach is summarized in Ullrich, *Standards of Patentability for European Inventions* where the author states:

> ". . . expressly abandoning its prior position, the CCPA has held and reaffirmed in a continuous line of decisions starting at about 1971 that subtest evidence, be it related to long-felt demand, failure or disbelief of others, superiority or commercial success, is of primary and imperative importance for the determination of non-obviousness and may not be disregarded even if obviousness is manifest. . . ."

The cases which the author cites for the quoted statement are *in re: Tiffin,* 443 F.2d 394 (CCPA 1971); *in re: McLaughlin,* 443 F.2d 1392 (1971); *in re: Palmer,* 451 F.2d 1100 (CCPA 1971); *in re: Mageli,* 470 F.2d 1380 (CCPA 1973); *in re: Fielder,* 471 F.2d 640 (CCPA 1973).

The basic argument of this Petition is that the Supreme Court should clarify the law, by making it clear to Courts of Appeals that questions of "unobviousness" should be resolved by employment of the Learned Hand/CCPA approach, that there is nothing unique about the decision of questions of "unobviousness", and that questions of "unobviousness" should be determined by thorough, judicious evaluation and consideration of all the relevant evidence, including the so-called "secondary evidence".

The "Learned Hand/CCPA approach" is consistent with reason, legal tradition, and the intent of Congress as set forth in the Patent Act of 1952. The case at bar presents an excellent opportunity[16] for this Honorable Court to focus with greater precision on the method which this Court initiated with the *Graham Trilogy,* to thereby afford the necessary stability, predictability and rationality to the patent system and to resolve the great inconsistency among

the various Circuits concerning the proper method to apply to the issue of "unobviousness" in a particular case.

The case at bar affords a clear illustration of the opposite results which can be obtained by the "visceral reaction method" as contrasted to the "Learned Hand/CCPA approach". If this case were viewed in the light of the "visceral reaction method" applied by some Courts of Appeals, one might reach the decision which the Court of Appeals here enunciated. Looking at the prior art and alleged prior art with that wonderful instrument — retrospective 20/20 hindsight[17] — one might well viscerally say: "an ordinary workman would have done this" — but, when one applies the "Learned Hand/CCPA approach," a different answer is compelled.

Davis/Doremus were at least reasonably skilled in the art of cathodic protection application. Doremus was a graduate chemical engineer with a masters degree. (TR. 176-177). He had been continuously active in the field of offshore pipe cathodic protection since its earliest years. (TR. 178). Doremus was nationally recognized and duly accredited as a Corrosion Specialist by the National Association of Corrosion Engineers. (TR. 208). He was a consultant and the author of technical articles appearing in the corrosion prevention literature. Davis' qualifications are also substantial, including an engineering degree and twenty-one years' engineering and sales experience. (TR. 157).

These two skilled men gave the awkwardness of the ASARCO Bulletin 191 bracelet anode virtually daily thought and attention for three years before conceiving the fundamental design which resulted in the Davis/Doremus apparatus. (TR. 232, *et seq.*). Their initial approach — strengthening or modifying the steel bands — proved the wrong approach and their experiments in that direction

were unsatisfactory. (TR. 579). When they finally conceived their fundamental design they were not even certain that their concept could be implemented practically in the unique environment in which the apparatus was installed. (TR. 580-584). If the Davis/Doremus device was obvious at "the time the invention was made", why did it take these highly-skilled and ingenious men three years to arrive at a workable solution?

There are approximately 1,500 accredited corrosion specialists in the United States. (TR. 207-208). Why, if the Davis/Doremus design was so obvious, had no one else discovered it during the decade that the cumbersome ASARCO Bulletin 191 bracelet anode was exclusively used in view of its widely discussed, highly objectionable shortcomings? In fact, if the Davis/Doremus device were so obvious, why did ASARCO initially design the admittedly clumsy, cumbersome ASARCO Bulletin 191 bracelet anode?

The Davis/Doremus apparatus, which was so obvious to the Court of Appeals panel deciding this case, was initially not fully appreciated by the Patent Examiner (TR. 272), a technically trained person with many years experience in examining cathodic protection devices. Only during the prosecution of the reissue application did the same examiner achieve a full understanding of the invention. (TR. 272, *et seq.*).

When the Davis/Doremus apparatus began to capture the market, ASARCO and BROYLES began frantic efforts to copy the Davis/Doremus apparatus. (TR. 650 *et seq.*, Trial Court Exhibits 23-A, *et seq.*). The documentation reveals that even with secretly taken pictures of the Davis/Doremus apparatus, it was not easy for ASARCO's research department to copy the concept. (See Trial Court Exhibits 23-A, *et seq.*). ASARCO's research personnel grappled with the problem for two to three years before

finally producing a reasonably effective copy of the Davis/Doremus device. (TR. 650 and Trial Court Exhibits 23-A, *et seq.*).

In fact, the inventors themselves, their original patent attorney (with more than 35 years of professional experience) the Patent Examiner and ASARCO's technical personnel all had difficulty initially in grasping the essence of the Davis/Doremus apparatus. Considering this factual background, the conclusion of the technically trained Patent Examiner, and the decision of a careful trial judge, might it not appear that an appellate court finding of obviousness may be an egregious example of what Justice Jackson terms "singular self-assurance."[8]

THE SOLUTION

Many of the problems with which this Honorable Court, and our society, manfully grapple in this age are essentially insoluble — at least in our generation. On the contrary, the problem to which this Petition is addressed has a simple, direct solution — despite the historical evidence to the contrary. This Honorable Court can engender enormous progress toward that "stabilizing effect" which Congress sought in the Patent Act of 1952 by granting this Petition, giving this case this Honorable Court's normal plenary, careful consideration, and thereupon adopting what the writer has called the "Learned Hand/CCPA approach", rejecting the "visceral reaction approach" and completing the teaching which the Court began — but did not complete — in the *Graham Trilogy*. Judge Rich in concluding an address in May of 1978 in Rochester, New York said:

> "Let's try to hang on for dear life to the little advances in the art of thinking about patent law that we are able to make in our lifetimes." 60 J.P.O.S. 271, 303.

In the same vein, Judge Rich has said:

> "The words of the statute (i.e., 35 U.S.C. § 103) are the tools of the law and should be kept clean and bright and sharp. Any lawyer or judge who deliberately dulls the meaning of words he understands by reference to confusing or confused texts or opinions is committing a professional crime.
>
> The ultimate reason for writing § 103 into the statutory law was that the requirement for invention was a lead razor which could not take an edge and which could be nothing other than a blunt instrument. Section 103 was enacted as a much better tool for the job." Rich, *Why and How Section 103 Came To Be,* 1977 Patent Law Conference Coursebook, BNA Publications.

A direct solution to the confusion surrounding "unobviousness" is within this Honorable Court's reach. The facts of this case present an unusually effective vehicle (as did *United States* v. *Adams),* for clarifing the law and righting of the injustice which occurred as a result of the Court of Appeals' Decision.

Thomas Jefferson was one of our Nation's first Patent Examiners. (See historical background of the *Graham Trilogy.*) That great innovator said:

> "I am not an advocate for frequent changes in laws and constitutions, but laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths discovered and manners and opinions changed, with the change of circumstances, institutions must advance to keep pace with the times. We might as well require a man to wear still the coat which fitted him when a boy as a civilized society to remain ever under the regimen of their barbarous ancestors."
>
> Northwest panel of Jefferson Memorial Washington, D.C.

Too long has this Nation had an essentially unpredictable, capricious patent law — creating a "notorious difference" between standards applied by the Patent Examiners and the Federal Judiciary, between the various Courts of Appeals and even between individual panels of the same Court. This case provides a vehicle for real progress in what Judge Giles Rich calls "the art of thinking about patent law".

PRAYER

Petitioner prays that this Honorable Court grant its Petition for Writ of Certiorari and upon final consideration review the judgment of the Court of Appeals and remand this case to the Trial Court for further proceedings consistent with the findings of the Trial Court. Alternatively, Petitioner prays that this cause be remanded to the Court of Appeals or the Trial Court with such instructions as appear to the Court to be legally and equitably appropriate.

Respectfully submitted,

By .....

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CERTIFICATE OF SERVICE

On this the 25th day of September, 1979, a true and correct copy of the foregoing instrument has been forwarded to counsel for Defendants, Ned Conley, Butler, Binion, Rice, Cook & Knapp, Esperson Buildings, Houston, Texas.

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FINIS E. COWAN

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[1] See detailed discussion of this assertion at pages 14 through 23 *infra* and in Footnotes 4, 6, 9, 10, 13 and 17.

[2] The basic concept and nomenclature of the cathodic protection apparatus has some similarities to the device considered by this Honorable Court in *United States* v. *Adams*, 383 U.S. 39, 86 S.Ct., 708, 15 L.Ed.2d, 572 (1966). A bracelet anode works much like a battery. (TR. 200-201) The objective of cathodic protection is to protect a structure of "more noble metal" by placing a "less noble" or "sacrificial" metal adjacent to the structure to be protected and inducing a very slight, continuous electrical current through the protective metal. This arrangement causes corrosion to occur in the sacrificial metal and protects the "more noble metal".

The "anode" is the body of sacrificial metal. The "cathode" is the metal to be protected. The anode (normally zinc, magnesium or aluminum) will normally have embedded in it a "core", usually of steel, which is connected by a wire conductor to the cathode, i.e., the metal to be protected, so that a complete circuit is created and a low grade current induced. (TR. 188-199).

[3] This case is an excellent example of the fact that instability in the patent system can and often does impact with greatest severity upon the small entrepenuer who attempts to compete with an industrial giant. In this connection, see Senate Report No. 1464, 84th Congress, Second Session:

> "The large number of patents held invalid has an especially devastating effect upon the independent inventor of small financial means. Because of the probability that infringement litigagation will result in judgment for the alleged infringer, it encourages a tendency to ignore the rights of patentees even where the patents are valid. Since prosecution of infringement suits is extremely slow and expensive, patentees may balk at undertaking it, even though satisfied that their patents are valid. Investment in inventions in consequence, is discouraged since the property value thereof is depreciated."

The case at bar illustrates that one of the best ways by which a small entrepenuer can compete effectively is to develop a superior product meeting the requirements of patentability and then obtain patent protection against blatant copying. ASARCO, or a company like ASARCO, has an enormous advantage in a patent war because of its ability to spend enormous sums upon litigation. Also obvious is the fact that this expense – and the resultant advantages to the industrial giant – is greater if patent cases are, in effect, decided in the Court of Appeals rather than in the Trial Court.

In one recent case tried in the Southern District of Texas – Houston Division, an inventor, Mr. Richard Self – testified that one of the principal reasons he sold his small company was that legal protection of his patents was necessary and he perceived that he would be unable to finance the extensive litgiation which he contemplated would be necessary to protect his very real innovation against infringers. See Civil Action No. H-77-819, *Control Components, Inc. and Richard E. Self* v. *Val Tech Inc. and Alpha Engineering Company*, presently pending before the Court of Appeals for the Fifth Circuit as No. 79-1626.

In this connection, see also Dr. Edwin H. Land (the founder of Polaroid), *The Role of Patents and the Growth of New Companies*, 41 J.P.O.S. 502 (1959); Crews, *Problems of the Independent Inventor*, 41 J.P.O.S. 159 (1959); Wolf, *Significance of the Patent System*, 42 J.P.O.S. 101 (1960); Perella, *The Influence of the Patent System on the U.S. Economy*, 49 J.P.O.S. 52 (1967).

The facile, simplistic assumption that there is a basic conflict between the patent and the antitrust laws has been authoritatively challenged. See Report of the Subcommittee on Patent, Trademarks & Copyrights, 85th Congress, Senate Report No. 72, First Session 1957.

In reading many of the opinions of the Courts of Appeals and this Honorable Court, one is tempted to believe that some of the judges may have forgotten the plight of Burt Adams *[United States* v. *Adams*, 383 U.S. 39, the third inventor in the *Graham Trilogy]*. Adams was an individual inventor with a patent issued in 1943. The United States Government, after repeatedly telling Adams that his apparatus was valueless, copied it, surreptitously infringed the patent, denied administrative compensation for five years, and appealed an obviously correct decision of the Court of Claims to this Honorable Court, where Adams finally received justice. See discussion of history of the Adams case at 72 Dick. L. Rev. 244, 254. The United States Government is not, of course, the only entity capable, on occasion, of this type of overreaching.

In this connection one thoughtful scholar has observed:

> ". . . the patent system must be considered to be directly based on the premise that it must work in an abstract and non-discriminatory manner for the small as well as for the powerful inventor, for significant as well as for minor inventions and that it constitutes only an element within the larger framework of the incentives and disincentives resulting from general market conditions, this element being the grant of an exclusive right as a means for making the patented teaching a scarce and therefore merchandisable asset."

Ullrich, *Studies in Industrial Property and Copyright Law*, Volume 1, p. 108 (1977).

[4] One major source of lack of stability and predictability in the patent system and the "notorious difference" (See language from *Graham Trilogy* at 383 U.S. 1) between the standards applied by Patent Examiners and the Federal judiciary is this Honorable Court's assertion in *Anderson's Black-Rock Inc.* v. *Pavement Salvage Company*, 396 U.S. 57, 90 S.Ct. 305, 24 L.Ed. 2d 258 (1969) and *Great Atlantic & Pacific Tea Company* v. *Supermarket Equipment Corporation*, 340 U.S. 147, 71 S.Ct. 127, 95 L.Ed. 162 (1950) that it is unlikely that any combination of old elements can produce a patentable invention. This assertion, upon analysis and study simply will not stand because it would render unpatentable even the most revolutionary innovations which clearly meet the statutory requirements of novelty, utility and unobviousness.

Judge Rich has eloquently pointed out in his famous article *Escaping the Tyranny of Words*, 60 J.P.O.S. 271 (1978) that George Eastman's original Kodak was a combination of elements. Rich says:

> ". . . that first roll film camera I mentioned was, of course, just a combination of old elements: a strip of paper, a film of cellulose nitrate, a photographic emulsion which had been used before on a glass support, a simple box, a shutter, winding spools and a lens. That was virtually all there was to it. Each element performed the same function it had always performed in the prior art except that the photosensitive element, the film, was capable of being rolled up – an obviously desirable thing to do . . . "

Judge Hand in *Reiner* v. *I. Leon Company*, 285 F.2d 501, 128 U.S.P.Q. 25 (2d Cir. 1960) said:

> "It is idle to say that combinations of old elements cannot be inventions; substantially every invention is such a 'combination': that is to say, it consists of former elements in a new assemblage. All the constituents may be old, if their new concourse would not 'have been obvious at the time the invention was made to a person having ordinary skill in the art' (§ 103, Title 35). That has been the statutory definition since January 1, 1953 . . . . "

Judge Eugene A. Wright in his excellent opinion in *Reeves Instrument Corp.* v. *Beckman Instruments Inc.*, 444 F.2d 263, 170 U.S.P.Q. 74 (9th Cir. 1971) said with reference to the concept that there is an unlikelihood of unobviousness in any combination of old elements:

"4. Carried even further, there is doubt that anything would be patentable. Not only are all mechanical and electrical devices constructed of old elements but all chemical products are the result of combining known chemical elements. To continue to reduce patentability with a view toward uses of old elements would ultimately lead to the conclusion that those 'inventions' which survive are unpatentable because they amount to a discovery of something which already existed in nature."

This Honorable Court at times in its past has recognized the truism that virtually all innovations are combinations of old elements. In 1853 this Honorable Court said:

"No invention can possibly be made consisting of a combination of different elements of power, without a thorough knowledge of the properties of each of them, and the mode in which they operate on each other. And it can make no difference, in this respect, whether he (the inventor) derives his information from books, or from conversation with men skilled in the science. If it were otherwise, no patent, in which a combination of different elements is used, could ever be obtained. For no man ever made such an invention without having first obtained this information, unless it was discovered by some fortunate accident."

O'Reilly v. *Morse*, 56 U.S. (15 Howard) 62; 14 L.Ed. 601 (1853).

[5] There was much controversy in the Trial Court as to whether or not Davis/Doremus' patent counsel had propertly submitted the pertinent prior art to the Patent Examiner; but it is manifest that the Trial Court's findings in this regard should be entitled to the protection of Rule 52(a), F.R.C.P. In addition, it is established conclusively (TR. 262-269) that Davis/Doremus, individually and through their counsel, submitted to the Patent Examiner the Bulletin 191 Booklet (Trial Court Exhibit P-18, Appendix D1 herein) and another article published by Doremus in which he described and published pictures of all of the various types of anodes customarily used upon offshore structures. (Trial Court Exhibit P-2, Appendix D-13 herein). It is submitted that these two items of prior art clearly contained the essential teachings found in the numerous patents upon which ASARCO relied. If the Trial Court's findings concerning the scope and content of the relevant prior art had been accorded their proper weight by the Court of Appeals, we submit that the Court of Appeals could not logically have reached the conclusion that the Davis/Doremus apparatus was obvious.

Arguably, if the case at bar had been tried to a jury, and the jury had returned special verdicts analogous to the trial court's findings herein, the Court of Appeals would have deferred to the jury's findings, and the legal conclusion of nonobviousness would have been compelled by the findings of fact. In a speech to the Conference of Chief Justices, Mr. Chief Justice Burger suggested that "some innovative lawyers should, as in deed some have done, waive juries in the complicated trials . . ." Remarks of Warren E. Burger to the Conference of Chief Justices, Flagstaff, Arizona, August 7, 1979 (Text available from The National Center for State Courts, Williamsburg, Virginia). (While the Chief Justice's remarks were chiefly directed to complex cases with exceptionally lengthy trials, it appears that his suggestion would be equally applicable to highly complex litigation, such as patent litigation, even if the trial were relatively short.) Indeed, the Court of Appeals for the Seventh Circuit has observed that "members of the Patent Bar have wisely avoided jury trials in patent litigation." *Panther Pumps & Equipment Co., Inc.* v. *Hydrocraft, Inc.*, 468 F.2d 225, 228 (7th Cir. 1972), cert. denied, 411 U.S. 965 (1963). However, if the Courts of Appeals continue to give mere lip service to the "clearly erroneous" standard under Rule 52(a) F.R.C.P., while granting much greater deference to the findings of a jury, it would appear that many more patent cases will be tried to juries in the future, especially if the patentee's case will turn on findings of fact in relation to the issue of "nonobviousness." The Seventh Circuit recently noted that the Court of Appeals was "bound to respect the factual basis of the jury's special verdict that the patents involved here are valid and not void for obviousness." *Dual Manufacturing & Engineering, Inc.* v. *Burris Industries, Inc.*, No. 79-1136 (7th Cir. July 20, 1979). Judge Pell in a dissenting opinion noted that

"This Court has never heretofore felt it was bound by a determination of nonobviousness resulting in validity even where that finding has been made by a District Court Judge, whose expertise in the subject presumably would be well above that possessed by a lay jury. See, e.g., *Skil Corporation* v. *Lucerne Products Co.*, 503 F.2d 745 (7th Cir. 1974), cert. denied, 420 U.S. 974 (1975); *Panduit Corporation* v. *Burndy Corporation*, 517 F.2d 535 (7th Cir. 1975), cert. denied, 423 U.S. 987; *Gentlemen Mfg. Inc.* v. *Lawn 'N 'Sport Powermower Sales & Service, Inc.* 517 F.2d 1194 (7th Cir. 1975); and *Burland* v. *Trippe Mfg. Co.*, 543 F.2d 588 (7th Cir. 1976)." Dual, *supra*.

It is submitted that Judge Pell's observation is indeed correct, and that the Courts of Appeals are generally much less likely to set aside a jury finding than the findings of a trial court. If this trend is allowed to continue unchecked by this Honorable Court, many members of the Patent Bar may well conclude that waiving a jury trial is no longer wise. A significant increase in the number

of jury trials in patent litigation has already occurred. See Wetzel, *A Survey of Patent Jury Litigation for the Last Fifteen Years*, 10 Intellectual Property L.Rev. 377 (1978). See *also*, Scott, *Jury Trials from the Defendants Perspective*, 10 Intellectual Property L.Rev. 419 (1978); Burton and Levinson, *Plaintiff's Use of Juries in Patent and Trademark Litigation*, 10 Intellectual Property L.Rev. 435 (1978). The case at bar presents an opportunity to clarify the "clearly erroneous standard" as well as the analysis of nonobviousness discussed *infra*.

[6] The House of Representatives Report on the statute which ultimately became the Patent Act of 1952 stated that § 103 was one of two "major changes or innovations in the title" and that it was added "for uniformity and definiteness" in the hope that it would have "a stabilizing effect and minimize great departures which have appeared in some cases." H. Rep. No. 1923, 82nd Cong. 2d Sess., on H.R. 7794, May 12, 1952, pp. 5, 7 and 18; Rich, *Escaping the Tyranny of Words*, 60 J.P.O.S. 271, 290.

Judge Rich, one of the draftsmen of the 1952 Patent Act has properly pointed out that 35 U.S.C. § 103 was:

> ". . . a carefully worked out statutory substitute for the rough-hewn stop gap the Courts produced which the Courts themselves could not explain." (i.e., concept of "invention").
>
> Rich, *Escaping the Tyranny of Words*, 60 J.P.O.S. 271, 278. (1978).

The 1952 Patent Statute was the culmination of a long period of study and analysis. This study and analysis commenced as early as 1941 when a commission appointed by President Roosevelt and headed by Charles F. Kettering made a report to Congress stating that:

> "One of the greatest technical weaknesses of the patent system is the lack of a definite yardstick as to what is invention. To provide such a yardstick and to assure that the various courts of law and the Patent Office shall use the same standards, several changes are suggested. It is proposed that Congress shall declare a national standard whereby patentability of an invention shall be determined by the objective test as to its advancement of the arts and sciences."
>
> Report of National Patent Planning Committee, June 18, 1943, House Document 239, 78th Cong. pp. 6, 10. Discussed at Rich, *The Vague Concept of Invention As Replaced by § 103 of the 1952 Patent Act*, 46 J.P.O.S. 855, 862 (1964).

For many years the Kettering Commission proposals met no success but, in the 79th, 80th, and 81st Congresses, from 1945 through 1949 identical bills were pending entitled "A Bill to Declare a National Policy for Determining Invention". See Rich, 46 J.P.O.S. 855 (1964).

Judge Rich, who may well be the most deeply informed and experienced student of the patent law in our society has consistently advocated the view that the 1952 Patent Act rendered previous cases talking about a "standard of invention" essentially obsolete and substituted therefor three basic statutory requirements for patentability, to-wit: novelty, utility and unobviousness. See, for example, his statement that:

> ". . . the 'requirement for invention' became obsolete in 1953 by an act of Congress, along with many prior court opinions discussing it, being replaced by unobviousness as defined in § 103 as the THIRD REQUIREMENT for patentability. . . ."
>
> Rich, *The Vague Concept of "Invention" as Replaced by § 103 of the 1952 Patent Act*, 46 J.P.O.S. 855, 874 (December 1964).

In this connection, Judge Learned Hand has said:

> "You could find nearly anything you like if you went to the opinions. It (i.e., the concept of 'invention') was a subject on which judges loved to be rhetorical."
>
> Hearings on S. Res. 92 before the Sub-Committee on Patents, Trademarks & Copyrights of the Senate Committee on the judiciary, 84th Cong., 1st Sess. 113 (1955).

All of the knowledgeable commentators agree that § 103 was designed to replace the vague and undefinable concept of "invention", which had been used as a totally non-objective tool for the purpose of denying the validity of a very large percentage of the patents presented for adjudication. With reference to the concept of "invention", Judge Rich says:

> "In the final analysis, all it amounts to was that if the court thought the invention, though new and useful, was not patentable, then it did not involve 'invention' and vice versa. The requirements for 'invention' was the plaything of the judges who, as they became initiated and knew its mysteries, delighted to devise and expound their own ideas of what it meant; some very lovely prose resulting."
>
> Rich, *Principles of Patentability*, 28 Geo. Wash. L. Rev. 393, 404 (1960).

Prior to the passage of the Patent Act of 1952, one observer described the mysteries surrounding the word "invention" as "an

enormous enveloping cocoon of metaphysical hocus-pocus". Hearings on HR-3760, *supra* Note 23 at 58.

The Patent Act of 1952 defined "invention" as the thing discovered or created (35 U.S.C. § 100) and then set forth in Sections 101 through 103 the conditions for determining whether a particular invention was patentable. Judge Rich, one of the chief draftsmen of the Act, has pointed out that this action was taken "in order to get rid of the vague requirement of invention". He observes:

> "Nowhere in the entire Act is there any reference to a 'requirement' of 'invention' and the draftors did this deliberately in an effort to free the law and the lawyers from bondage to that old and meaningless term. . . ."
>
> Rich, *Congressional Intent – or, Who Wrote the Patent Act of 1952?*, Patent Procurement and Exploitation 61, 70 (1963).

Congress explicitly rejected the "flash of creative genius" language by the addition of this last sentence of § 103 to the effect that:

> ". . . patentability shall not be negatived by the manner in which the invention was made."

The Reviser's note also stated that:

> "It is immaterial whether the invention resulted from long toil and experimentation or from a flash of genius."

Further evidence of the intent of Congress to induce a more hospitable attitude toward the validation of patents is evidenced by the inclusion in the Patent Statute of 1952 of the presumption of validity, which was incorporated into the statute for the first time.

Congress, in drafting § 103 made a definite and recognizable effort to avoid the use of the undefinable word "invention" and instead substituted, to the extent possible, an objective standard of patentability which could lead to some uniformity of result. See Harris, *Section 103 Revisited*, 9 Idea 617. Justice Hand, one of the most profound scholars of our patent system, had just two years before the 1952 Patent Act described the concept of "invention" as: "fugitive, impalpable, wayward and vague a phantom as exists in the whole paraphernalia of legal concepts." *Harries* v. *Air King Products Company*, 183 F.2d 158, 162 (2d Cir. 1950).

This Honorable Court in the *Graham Trilogy* recognized that § 103 was added to insure "uniformity and definiteness", 385 U.S. at 15 and espoused "strict observance" of the requirements set down in the *Graham Trilogy* so as to bring about "that uniformity

and definiteness which Congress called for in the 1952 Act." 382 U.S. at 18.

For detailed discussion and information from a number of the draftsmen concerning the Congressional history of § 103 see: Rich, *Congressional Intent – Or, Who Wrote the Patent Act of 1952?*, 1977 Patent Law Conference, Nonobviousness: The Standard of Patentability in the United States, Conference Course Book of BNA's Patent, Trademark & Copyright Journal, United States Patent Quarterly – September 7-9, 1977 (hereinafter "1977 Patent Law Conference"); Rich, *Why and How Section 103 Came To Be*, 1977 Patent Law Conference; Frederico, *Further Comments and Observations on the Origin of 103*, 1977 Patent Law Conference p. 1:301; Frederico, *Origins of Section 103*, APLA Quarterly Journal, Volume V No. 2, 1977 pp. 87-98.

[7] Several studies have compiled statistics on validity adjudications in various circuits for prescribed test periods. Horn and Epstein, found that in the decade of the 60's the Fifth Circuit invalidated 64% of the 73 patents litigated before it, the Seventh Circuit invalidated 47% of 129 patents litigated, the Third Circuit invalidated 86% of 42 patents litigated, the Second Circuit invalidated 76% of 59 patents litigated and the Ninth Circuit invalidated 84% of 101 patents litigated. Horn and Epstein, *The Federal Courts' View of Patents – A Different View*, 55 J.P.O.S. 134, 146 (1973). Another study has focused on the period from 1966 to 1972 and found that the Fifth, Sixth and Seventh Circuits all invalidated over 54% of the patents adjudicated in those circuits, while the Fourth, Eighth and Ninth and D.C. Circuits invalidated over 83% of the patents adjudicated before those circuits. See *Collateral Estoppel and Patent Litigation*, 18 Villanova L. Rev. 297 (1972).

[8] *Jungersen* v. *Otsby and Barton Co.*, 335 U.S. 560, 69 S.Ct. 269, 93 L.Ed. 235 (1949). His exact language was:

> "I think this patent meets the patent statutes' every requirement. And, confronted by this record, an industry heretofore galled by futility and frustration may well be amazed at the Court's dismissal of Jungersen's ingenious and successful efforts. . . . it would take a singular self-assurance on the part of one who knows as little of this art as I do, or I can learn in the few hours that can be given to consideration of this case, to ignore the judgment of these competitors who grew up in the industry and say that they did not know something new and useful when they saw it. . . . it would not be difficult to cite many instances of patents that have been granted, improperly I think, and without adequate tests of invention by the patent office. But I doubt that the remedy for such patent office passion for granting patents is an equally strong passion in this

Court for striking them down so that the only patent that is valid is one which this Court has not been able to get its hands on. I agree with the opinion of Judge Learned Hand below."

[9] Judge Giles S. Rich, Associate Justice, CCPA recently said in an address before the American Patent Law Association that:

"To point up the problem, I quote the conclusion of a speech made by a Chicago lawyer at a John Marshall Law School Seminar just a few weeks ago entitled 'Synergism in the Lower Federal Courts'. He said:

> 'It can hardly be denied that recent decisions by the Supreme Court in patent validity cases are illogical, contrary to the patent statute, and self-contradictory. . . .'

"I agree. . . ."

Rich, *Escaping the Tyranny of Words – Is Evolution and Legal Thinking Impossible?* 60 J.P.O.S. 273 (1978).

This is only the most cogent of many similar criticisms. For other authoritive criticisms, see:

> Professor Irving Kayton, Professor of Law and Director, Patent Law Program, the George Washington University, Washington, D.C. has recently written:

". . . even today, the meaning of § 103 is anything but clearly judicially established. It is safe to say, as the discussion below will demonstrate, that the various circuits of the United States Courts of Appeals and the Supreme Court of the United States differ seriously among each other (as do the three judge appellate panels within circuits) with regard to the meaning of 'nonobviousness' . . ."

Kayton, *Nonobviousness of The Novel Invention* – 35 U.S.C. § 103, Patent Preparation and Prosecution Practice (1976 Patent Resources Institute, Inc.)

[10] Prominent members of the Federal Judiciary have manifested an apparent, pervasive bias toward the patent system and, arguably, a simple unwillingness to follow the mandate of Congress in the 1952 Patent Act. Examples of this are not hard to find. For example, Justice Douglas in *Great Atlantic & Pacific Tea Company* v. *Supermarket Equipment Corporation*, 340 U.S. 147, 71 S.Ct. 127, 95 L.Ed. 162 (1950) described in withering, harsh terms numerous "gadgets" upon which the Patent Office had issued patents, assertedly for the purpose of expanding its own jurisdiction. Scholars have pointed out that each of the so-called "gadgets" which Judge Douglas condemned had been patented more than 50 years before 1950, the date of his opinion in the

"gadget" case. See Kimball, *An Analysis of Recent Supreme Court Assertions Regarding a Constitutional Standard of Invention*, 1 ALPA Quarterly Journal 204.

Another example, is Justice Brennan's famous footnote in *Sakraida* v. *Ag Pro*, 425 U.S. 273 at 275 in which a passage from Witt, *Classic Mythology*, was cited in support of the questionable assertion that: "systems using flowing water to clean animal wastes from barn floors have been familiar on dirty farms since ancient times." Manifestly, a myth does not support Justice Brennan's broad statement.

It is well recognized in the literature in this area that one of the motivating factors in Congress' enactment of the Patent Act of 1952 was adverse reaction to Justice Douglas' extreme language and enunciation of the "flash of creative genius" test in *Cuno Engineering Company* v. *Automatic Services Corp.*, 314 U.S. 84 62 S.Ct. 37, 86 L. Ed. 58 (1941). See Reilly, *A Post-Ag Pro look at United States* v. *Adams*, 1977 Patent Law Conference Course Book.

It is easy to dismiss language and references of this nature as mere "rhetorical flourishes", but language in decisions of the type here criticized cannot be overly emphasized when their effect upon the lower courts is considered. Imagine, for example, the effect which Justice Douglas' language about "gadget patents" has upon a newly appointed or otherwise patent inexperienced lower court judge who has never before tried a patent case, who is not acquainted with the extensive literature and history in this area and who does not know that the "gadget patents" which are condemned were issued over 50 years ago.

Lower court attitudes toward the patent systems are, it is respectfully submitted, affected as much by the language and attitude of this Honorable Court as by the specific holdings.

Illustrating a perception of judicial bias, Judge Giles Rich of the CCPA, has flatly stated that one simply cannot get to the Supreme Court unless a patent has been declared valid in the Court of Appeals. Rich, *Escaping the Tyranny of Words*, 60 J.P.O.S. 271, 278 (1978). Recent history would seem to support this conclusion.

Some scholars have suggested that no mundane innovation – no matter how novel, useful and nonobvious, can be validly patented. For example,

Professor Kayton says:

". . . there seems to be a psychological bent even today in the Supreme Court for withholding patent protection from inventions that appear technologically mundane, such as plows and devices for dispensing liquids from bottles."

Kayton, *Nonobviousness of the Novel Invention* – 35 U.S.C. § 103, Patent Preparation and Prosecution Practice (1976 Patent Resources Institute Inc.)

[11] Justice Clark in the *Graham Trilogy* pointed out the "notorious difference" between the manner in which patent examiners and the Courts of Appeals apply the statutorily mandated test of patentability. 383 U.S. 1 at 18. One of the stated purposes of the Supreme Court in connection with the detailed study which it gave to the *Graham Trilogy* was to attempt to resolve and improve this "notorious difference". History has shown that this commendable effort commenced in the *Graham* case has thus far been unnecessarily unsuccessful.

It can be and has been and is here argued that this Honorable Court's decisions since the *Graham Trilogy*, have not completed the teachings of the *Graham Trilogy*, but in fact have interrupted and confused what began as a commendable and constructive effort in the *Graham Trilogy*. See discussion at Footnote 14 herein.

[12] One commentator says:

". . . have you ever seen a better articulation – so far as it goes – of what one does to develop a reliable patentability opinion? . . ."

Schneider, *Nonobviousness, The Supreme Court, and the Prospects for Stability*, 60 J.P.O.S. 310 (1978).

[13] An excellent argument can be made that Trial Court determinations of obviousness – whether made by a court or a jury – should be regarded as findings of fact, and not of law, and afforded the same presumptions of correctness as other Trial Court determinations are afforded under Rule 52(a), F.R.C.P. At present, at least in the metropolitan Houston area, most juries contain at least one or more members with technical training. Virtually every jury will contain members who work daily with machinery and who have much more expertise, experience and know-how in dealing with machinery and technical matters than do most judges. In any event, juries and trial courts are just as competent to decide questions of unobviousness as they are questions relating to negligence, professional malpractice, product defectiveness and market value. Affording trial court determinations in the unobviousness area the presumptions of Rule 52(a) would have a great tendency to promote the stability which Congress sought in the Patent Act of 1952.

The percentage of patent cases (as distinguished from other varieties of litigation) appealed is materially greater in patent cases. (See Wepner, 56 J.P.O.S. 216, 225). As long as "unobviousness" is a question of law, it is surprising that any patent case can be disposed of at the trial court level, except by compromise settlement. A trial judge trying a patent case might well conclude that while he is deciding some questions with finality, with reference to the key question of unobviousness, he is in most instances merely giving the litigants a ticket to the Court of Appeals. One scholar says:

". . . thus, to a great extent, the Courts of Appeals must duplicate the efforts of the trial judges in patent cases. An appeal on the issue of validity is in some aspects like a trial *de novo* . . . it seems clear that the Courts of Appeals are spending a vast amount of time on this single issue of validity."

Wepner, *supra*. p. 28.

The scholarly literature, and the cases, echo (with *almost* complete unanimity) the well-established principle that the determination of a question of unobviousness is a question of law; however, virtually nowhere is there any lucid or sensible explanation as to why this should be the case and why questions of "unobviousness" should fall within a different category than questions of negligence, fair market value, defectiveness, seaworthiness, air worthiness, crash worthiness and other complex questions which are customarily decided, with a considerable degree of finality, at the trial court level.

Judge Rich has suggested in his article *"The Vague Concept of Invention as Replaced by Section 103 of the 1952 Patent Act"*, 46 J.P.O.S. 855, (1964) that a simple, straightforward application of the requirements of patentability as set forth in § 103 of the Patent Act of 1952 would remove the complexities of deciding whether nonobviousness is a question of law or fact. Judge Rich asserts that the presence or absence of "invention" before 1953 was always basically a decision of public policy question, which was properly left to the Court. Judge Rich goes on to explain:

". . . the presence or absence of 'invention' before 1953 was always, in my judgment, the determination of an issue of public policy – what inventions should be patented. As such it is a 'question of law'. This policy has now been Legislatively expressed in § 103. In that Section (Note 25 *supra*) the following potential issues of fact appear:

(1) What are the differences between the 'invention' and the 'prior art'?

(2) What is disclosed by the prior art presumed to have been available to the inventor?

(3) What was the level of ordinary skill in the art at the time the invention was made?

(4) Other fact issues relating to circumstances indicative of the presence or absence of obviousness, traditionally taken into account in determining 'invention', such as long felt need, immediate copying, sudden displacement of existing practices or devices, difficulty of achievement, a failure of others, etc. Once these facts have been assembled, there remains the ultimate statutory requirement of unobviousness, the third requirement for patentability, which becomes a matter of statutory application and as such must be a question of law. . . ."

The problem in Judge Rich's reasoning, as set forth above, this writer respectfully asserts, is that Judge Rich may not understand how so-called mixed questions of law and fact are customarily litigated and submitted to jurors in other areas of the law. Every mixed question of fact and law, such as negligence, defectiveness, seaworthiness, air worthiness, crash worthiness and market value depends upon multiple subsidiary factual inquiries, none of which, however, is an ultimate factual issue. The issue is "unobviousness". The decision of that issue is and should be dependent upon multiple factual inquiries and the consideration of multiple factors in the normal case, but the issue is "unobviousness" – not the subsidiary factual inquiries. Petitioners respectfully assert that there is no real reason why the question of unobviousness should not be decided finally, and with full protection of Rule 52(a) by either a trial court or a jury who has had an opportunity to see all the witnesses testify, personally examine the exhibits while being explained by live witnesses, and who has normally had a much better opportunity to give sustained and thoughtful attention to the problem than has an appellate judge, with a very large workload and a cold record.

Judge Rich is, however, undoubtedly correct in his explanation that the status of "unobviousness" is a law question as a matter of historical development. Up until the Patent Act of 1952 the only statutory requirements for patentability were novelty and utility. The courts filled the gap by devising the unworkable and undefinable concept of "invention", which was in effect replaced by what was hoped to be the more objective measure expressed in 35 U.S.C. § 103, defining "unobviousness". Before the Patent Act of 1952, decisions of questions as to "invention" obviously could not be submitted to a jury because there was no way to define "invention" and because the decision of whether or not a device was an "invention" was basically a decision of public policy, a matter not normally left to the decision of a jury.

If, however, the draftsmen of the Patent Act of 1952 have ultimately been successful in preparing an objective definition of "unobviousness", there is no real reason why this determination

should not be made with a reasonable degree of finality by a trial court or jury.

Petitioner respectfully submits that considerable stability could be created in the administration of the patent laws by commencing to treat questions of unobviousness just like other mixed questions of law and fact which are customarily submitted to a jury at a trial court level or decided by a trial court, with the finality implied by Rule 52(a), F.R.C.P.

[14] It is true, of course, that this Honorable Court has written on the 1952 Patent Act since the *Graham Trilogy*. Arguably, none of the later cases has made a meaningful contribution toward achieving stability in the administration of the patent laws.

Anderson's Black-Rock, Inc., v. *Pavement Salvage Company*, 396 U.S. 57, 90 S.Ct. 305, 24 L.Ed. 2d 258 (1969) was a case in which the Trial Court decided the question of unobviousness against the patent owner, the Fourth Circuit Court of Appeals reversed, and this Honorable Court, in effect, tried the question of obviousness *de novo* and agreed with the trial court.

A study of Justice Douglas' opinion in *Black-Rock* reveals that the Court's reasoning there was predicated primarily upon an assumption that a patentable device cannot be found in a combination of old elements known to the prior art. The simplistic view that a combination of old elements cannot lead to a patentable device is inconsistent with *United States* v. *Adams*, 383 U.S. 39 (1969) (the third case of the *Graham Trilogy*), and also is inconsistent with the plain words of the 1952 Patent Act. The 1952 Patent Act establishes three requirements for patentability – novelty, usefulness and unobviousness. There is no statutorily imposed requirement that a patentable devise not be a combination of old elements and some of the most astute writers in this area have pointed out that virtually any patentable apparatus is a combination of old elements and works in accordance with well-known rules of physics or chemistry. (See FN 4).

It has been persuasively argued that this Honorable Court in *Anderson's Black-Rock, Inc.* v. *Pavement Salvage Co.*, *supra* disregarded both § 103 and the teaching of the *Graham Trilogy*. The previously "Fourth" Circuit Court of Appeals there, in validating the patent, had relied upon extremely persuasive secondary evidence of long felt but unsatisfied need and initial skepticism among those in the art that the patented device would work. The message which a lower court would receive from *Anderson's Black-Rock* is that a court attempting to follow the Supreme Court would be well-advised to disregard secondary considerations entirely. See discussions of *Anderson's Black-Rock* in Damarest, *The Statutory Standard of Patentability: The Necessity For A Relative Standard Dependent Upon Factual Inquiries*, 12 Boston Col. Ind. & Com. Law Review 917.

The result, the reasoning employed and the treatment of the patent law in *Anderson's Black-Rock* have been widely criticized. It simply cannot be denied that that decision defeated the reasonable expectations of the owner of the patent.

Some scholars have argued persuasively that *Anderson's Black-Rock* almost totally negated the progress toward stability and clarity which *Graham* had accomplished. Mintz and O'Rourke argue that:

> "The Fourth Circuit opinion (i.e., in *Anderson's Black-Rock*) represented an able application of the test of nonobviousness. Its review would have been an excellent opportunity for the Supreme Court to reaffirm the standards of § 103 set forth in the trilogy – particularly as they related to mechanical combinations – and to quell the vitality of the tests of 'invention' stated in *Lincoln* and *A&P*. Indeed, certiorari was granted, but the result was not a restatement of *Graham*. To the contrary, in an almost incredible reversal of position, the old tests of 'invention' were elevated to the status of new tests of patentability and the plain language of § 103, the Legislative purpose and the Court's previous construction were nullified . . . it is apparent that the court (i.e., in *Anderson's Black-Rock*) resolved the validity of the patent on the basis of 'invention'. This is a plain reversal of the trilogy instruction to emphasize the nonobviousness test of § 103. While the Fourth Circuit was persuaded by nontechnical evidence, the Supreme Court treated such 'secondary considerations' as irrelevant. The Court resorted to A&P for the proposition that these matters 'without invention will not make patentability'. This view also represents a complete reversal of the trilogy, as the court there indicated that such factors were to be considered in the course of rendering a decision on obviousness."
>
> Mintz and O'Rourke, *After Black Rock: "New Tests of Patentability – The Old Tests of Invention"*, 39 Geo. Wash. L. Rev. 123.

Dann v. *Johnston*, 425 U.S. 219, 96 S.Ct. 1393, 47 L.Ed. 2d 692 (1976) was again a case in which this Honorable Court was simply called upon to try the question of nonobviousness *de novo* and concluded, primarily based upon its own analysis of the prior art that:

> "Assuming such an awareness, respondents system would, we think, have been obvious to one 'reasonably skilled in the applicable art' . . . the gap between the prior art and respondents system is simply not so great as to render the system nonobviousness to one reasonably skilled in the art."

Dann v. *Johnston* was an unusual case in which the owner of the patent was not able to argue and did not argue that the "secondary considerations" supported patentability and thus *Dann* v. *Johnson* affords no guidance to the bar as to how Patent Examiners or Lower Courts are to analyze and weigh the "secondary considerations".

Arguably, this Honorable Court's opinion in *Sakraida* v. *Ag Pro Inc.*, 425 U.S. 273, 96 S.Ct. 1532, 47 L.Ed. 2d 784 (1976) has also added to the confusion. This argument would be supported by pointing out that this Honorable Court's decision in that case was primarily predicated upon the erroneous assumption that it is highly unlikely that a patentable apparatus can ever be found in a combination of old elements. This concept was, before *Sakraida*, most recently promulgated in *Great Atlantic & Pacific Tea Company* v. *Supermarket Equipment Corp.*, 340 U.S. 147, 71 S.Ct. 127, 95 L.Ed. 162 (1950). In addition, *Sakraida* is simply not consistent with the teaching of the *Graham Trilogy* to the effect that attention should be closely focused on the requirements of 35 U.S.C. §§ 101, 102, 103. A plain reading of the statute reveals that a combination of all elements may certainly be patentable if the combination meets the requirements of nonobviousness.

Supporting the view that *Sakraida* has contributed to the confusion surrounding patent law, and not the clarity in the law, are Judge Rich's comments in his recent article *Escaping the Tyranny of Words*. Judge Rich says concerning *Sakraida:*

> "MOST PATENTABLE INVENTIONS ARE COMBINATIONS
>
> I deplore the quotation from A&P about improbability of combination of old elements being patentable inventions, of course, because practically all patentable inventions are combinations of old elements, as I expect the Supreme Court to acknowledge publicly someday because I believe it already recognizes that irrefutable fact. After all, it was just that which it held patentable in *United States* v. *Adams*, 383 U.S. 39 (1966), given the evidence to show unobviousness.
>
> Far from being an improbable place to find patentability, the new and unobvious combination is the usual place for finding it. This is a truism to any patent examiner or patent lawyer, but the Supreme Court hears patent cases so seldom as not to know it. Consider the telling sentence opening the opinion in Graham:
>
> 'After a lapse of fifteen years the Court again focuses its attention on the patentability of inventions***,' that last focus was in A&P decided almost two years before the effective date of the new patent act and its new § 103.

The real flaw in the Supreme Court's opinion in *Ag Pro* is its apparently unthinking adherence to the outworn and unhelpful A&P requirement for 'invention', after telling the world in *Graham* that Congress has 'emphasized nonobviousness as the operative test', which is 'the new statutory formulation' to be approached by the three step factual inquiry *Graham* dictates, 'strict observance of which will result in that uniformity and definiteness which Congress called for.' How can the Court expect the Patent and Trademark Office and the lower courts to follow its *Graham* directive that their inquiry as to patentability 'must be deemed with greater intensity on the requirements of § 103 when it illogically reverts, as it seems to do at the end of the *Ag Pro* invention, to the antiquated A&P 'invention' standard? Reason and logic cannot have it both ways.

Rich, *Escaping the Tyranny of Words*, 60 J.P.O.S. 271, 295-296 (1978).

The language, approach and result in *Anderson's Black-Rock* and *Sakraida* simply cannot be reconciled with the *United States* v. *Adams* (the third case of the *Graham Trilogy*), 383 U.S. 39 (1966). Professor Kayton points out in this regard that:

". . . the structure claimed in the Adams patent was as similar physically and chemically to the prior art as was possible without direct anticipation. The Adams battery used electrodes of cuprous chloride and magnesium, a combination of electrodes never before found in a single battery. The prior art, however, had taught that cuprous chloride electrodes were 'equivalent' to silver chloride electrodes and that magnesium electrodes were the 'equivalent' of zinc electrodes, with both zinc and silver chloride having been taught in the prior battery art as electrode material. . . . the finding of validity in Adams properly underscores the fact that courts should marshal all the evidence before deciding whether a particular invention is obvious or nonobvious. In a given technology, a small structural change may portend a monumental new discovery, whereas large structural differences may only evidence a 'Rube Goldberg' approach to a simple problem. . . ."

Charles Reed, Justice Clark's Law Clerk at the time of the extensive work which this Honorable Court did in the *Graham Trilogy*, has stated, with reference to cases subsequent to *Graham*, that:

"In reading the latter cases, I lament along with you the fact that the courts have strayed from the methodology in the trilogy cases. There has been a failure to appreciate that methodology. I do not criticize or attribute blame. It is a case of miscommunication, the same kind that lead some to read in Justice Douglas' 'flash of genius' something that was never intended."

Read, *Some Reflections on Graham* v. *John Deere Company*, Continuing Legal Education 1977 Patent Law Conference Book, p. 2:301 (1977).

John A. Reilly, the eminent counsel who prepared, tried and argued *United States* v. *Adams*, 383 U.S. 39 (1966) (the third case of the *Graham Trilogy*) has publicly advocated to patent counsel that, in trying their cases, they manfully attempt to reconcile *Graham Trilogy* with *Sakraida*, *Anderson's Black-Rock* and *A&P*. See Reilly, *A Post-Ag Pro Look at United States* v. *Adams*, Continuing Legal Education 1977 Patent Law Conference Course Book, p. 2:401 (1977). Study of Mr. Reilly's work, however, persuades one that the reconciliation of these cases is a task which can be achieved only with the greatest of ingenuity. An objective analysis of these cases persuades one of the justice of Judge Rich's comments to the effect that the cases simply cannot be reconciled and are internally inconsistent and self-contradictory.

The truth of the matter is this:

A lower court attempting to follow the mandate of this Honorable Court would obtain and does obtain an entirely different message from *Anderson's Black-Rock* and *Sakraida* than he would receive from a study of the *Graham Trilogy*. The message of the *Graham Trilogy* is that an applicant for or a holder of a patent may have a difficult time sustaining validity but that he at least has an honest run. The message of *Sakraida* and *Black-Rock* is that the easy, and probably the proper action for any lower court judge is to simply invalidate any patent that bears any arguable relationship to any prior art.

The confusion of the lower courts has been reinforced by Mr. Justice White's dissent from denial of a Petition for Writ of Certiorari in *Roanwell Corp.* v. *Plantronics, Inc.*, 429 U.S. 1004, 97 S.Ct. 538, 50 L.Ed. 2d 617 (1976). Mr. Justice White says:

"This court long ago established that the *sine qua non* of patentability is 'invention'. . . . The district court here made no finding that the combination produced a synergistic or any other nonobvious result.

• • •

Rather than ending its inquiry with this total lack of nonobvious improvement over the prior art, the district court went on to consider the need for respondent's device, prior failures in 'discovering' it despite intensive efforts, and respondent's commercial success. (Footnote omitted.)

Based solely on its historical review of various efforts to improve on previously existing devices, the trial court concluded:

> 'Indeed, as simple as the invention now appears, it would seem presumptuous to the point of arrogance to conclude that it was 'obvious' to persons of ordinary skill in the art, notwithstanding their lengthy and unsuccessful struggle to achieve such results.' (Cite omitted).

The district judge gave no indication as to what aspect of respondents device could be considered nonobvious to the assiduous researchers in the field. (footnote omitted). Rather, he found that the requirement of nonobviousness was satisfied simply because no one had created the successful combination before respondent secured his patent. In doing so, the court departed from the clear teachings of this court's prior cases." 429 U.S. at 1004-1008.

If Mr. Justice White's view is correct, then it should be clearly stated in a majority opinion of this Court. If as Mr. Justice White contends, this evidence is an insufficient basis to support a finding of nonobviousness, then great judicial economy in the lower federal courts would be accomplished by the elimination of these issues from consideration. On the other hand, if as the petitioner contends herein, all evidence is to be considered and evaluated in each case as to its probative value, this Court could effect greater stability and uniformity among the Circuits by removing the stigma from certain types of evidence which arises from the characterization as "secondary".

The conflicting views between the Circuits as to the treatment of secondary evidence are clearly exemplified by the Second Circuit's approval of the trial court's holding in *Plantronics*, which was clearly based on "secondary considerations". In contrast, the trial court's findings of ASARCO's difficulty in even copying petitioner's apparatus was given no weight by the Fifth Circuit in the case at bar. A clarification of this issue by this Honorable Court would contribute both to judicial economy and to uniformity among the Circuits by clarifying the probative value to be accorded to "secondary evidence".

[15] One of the scholarly articles cited in the *Graham Trilogy* is Robbins, *Subtests of Nonobviousness: A Non-Technical Approach To Patent Validity*, 112 Pa. L. Rev. 1169 (1964). Mr. Robbins, focusing upon the peculiar manner in which "unobviousness" has been handled by the law says:

> "The application of legal standards to factual situations is often governed by vague or conclusory criteria. Standards such as 'reasonable man' or 'due process' have acquired a more definite legal content through repeated exposure to judicial treatment. However, the legal standards applicable to the validity of patent grants have not enjoyed the benefit of such a transition. . . ."

Virtually since the enactment of the Patent Act of 1952 some courts and legal scholars have argued that greater stability and predictability could be imparted to the patent system by making it clear that questions of "unobviousness" should be decided like any other question of fact and law, that is, by detailed consideration of all of the facts relevant to the question and evaluation of that evidence in the light of all of the facts and circumstances. Cases prior to 1964 applying this approach are collected by Professor Robins in his article, *Subtests of Non-Obviousness: A Technical Approach to Patent Validity*, 112 Pa. L. Rev. 1169 (1964) and are excellently illustrated by Judge Learned Hand's superb opinions in *Reiner* v. *I. Leon Company*, 285 F.2d 501, 128 U.S.P.Q. 25, 2d Cir. (1960), cert. denied, 366 U.S. 929 (1961) and *Lyon* v. *Bausch & Lomb Optical Company*, 224 F.2d 530 (2d Cir. 1955 – See Footnote 12).

[16] Surely this Court has not written the last word on the Patent Act of 1952 and the manner in which lower courts and patent examiners are to deal with the question of "unobviousness". In 1964 Judge Giles S. Rich said:

> "Then began our patent system. One might describe it as a great experiment which goes on continuously, getting more complex all the time, in which this institute (i.e. the Patent, Trademark & Copyright Research Institute of the George Washington University) is playing for the first time, a vital role in finding out how the system as a whole actually works, as an aid to preserving its basic principles and saving the obvious good that is in it."
>
> Rich, *The Vague Concept of "Invention" as Replaced by Section 103 of the 1952 Patent Act*, 46 J.P.O.S. 855, 858.

The basic thesis of this Petition is that this case presents an excellent opportunity for this Honorable Court to make a timely and needed contribution of new light to this "great experiment".

[17] The statutory language itself cautions against the use of hindsight in determining questions of nonobviousness. The statute says:

> ". . . if the differences between the invention . . . and the prior art would have been obvious *at the time the invention was made* (emphasis added) . . ."
>
> 35 U.S.C. § 103.

APPENDIX A

IN THE

United States District Court

FOR THE SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION

CIVIL ACTION
No. 72-H-1002

CATHODIC PROTECTION SERVICE,
Plaintiff,

v.

ASARCO INCORPORATED, ET AL,
Defendants.

MICHAEL P. BRESTON
Houston, Texas
for Plaintiff.

NED L. CONLEY AND ELLIOTT COX, BUTLER,
BINION, RICE, COOK & KNAPP
Houston, Texas
for Defendants.

REVISED FINDINGS OF FACT AND CONCLUSIONS OF LAW

This is a suit for patent infringement. Plaintiff accuses the defendants of infringing United States Letters Patent No. Re 27,529 ("the reissue patent"), issued December 12, 1972, on an application filed August 7, 1972. The patent is a reissue of Patent No. 3,616,422 ("the original patent"), which issued on October 26, 1971, as a result of an applica-

tion filed April 21, 1969. The original patent and the reissue patent were issued in the names of Gordon L. Doremus and Jack G. Davis.

Trial was had to the Court, which has considered the testimony, exhibits and documents submitted as evidence in this case. As the following Findings of Fact and Conclusions of Law indicate, this Court is of the opinion that the reissue patent is valid and that it has been infringed by the activities of the defendants. Plaintiff is therefore entitled to declaratory and injunctive relief in accordance with this opinion.

I. FINDINGS OF FACT

A. General Backgound

1. Parties

1. Plaintiff is a partnership organized under the laws of Texas, with its principal place of business in Houston, Texas. Plaintiff is engaged in the cathodic protection business. At the time of filing the application for the original patent and the reissue patent, Gordon L. Doremus was a partner in the plaintiff company and was highly skilled in the art of cathodic protection of offshore pipelines (Pltf.'s Exhibit 20). Jack G. Davis was an engineer employed by plaintiff who had obtained extensive field experience in the application of cathodic protection to large offshore pipelines.

Plaintiff has been in the cathodic protection business for over twenty-five years, offering complete cathodic protection services, such as design and installation of cathodic protection systems, furnishing material and equipment for such systems, and selling cathodic protection equipment to others. As a part of such business, plaintiff has sold and installed galvanic anodes of many sizes and shapes for many different applications.

2. Defendants ASARCO Incorporated and Federated Metals Corporation, the former American Smelting and Refining Company and its Federated Metals Divisions, (ASARCO) are New Jersey corporations with offices and plant facilities in Harris County, Texas, which are in the business of reclaiming secondary metals and producing non-ferrous products, including galvanic anodes. ASARCO is a supplier of zinc and has for many years manufactured zinc anodes for use in offshore applications, such as on ship bottoms and on other underwater equipment. These galvanic anodes are sold to the industry through a network of distributors. Plaintiff and defendant Broyles are distributors of ASARCO's galvanic anodes.

3. Defendant Broyles is a Texas corporation, founded in 1954, with a main office located in Harris County, Texas. Defendant Broyles competes with plaintiff and offers a complete cathodic protection service, selling and installing galvanic anodes of many sizes and shapes.

2. Cathodic Protection Via Galvanic Bracelet Anodes

4. Over the last several decades, a larger number of oil wells have been drilled in the Gulf of Mexico and in other offshore locations. To a major extent the oil produced from those wells has come to be transported to the mainland through underwater pipelines which are positioned on the ocean floor. These pipelines are often quite large, being between 16″ and 36″ in diameter.

In order to prevent corrosion of such pipeline by sea water, the pipeline is coated with a coating of epoxy, tar, or mastic materials. Since such pipelines carry either oil or gas, both of which are lighter than water, large diameter lines tend to float. Accordingly, these lines are usually covered with a coating of concrete, which may be from one inch to three inches or more thick, to cause the pipeline to remain positioned on the ocean floor.

The protective coating on the pipeline has unavoidable "holidays", or small openings, through which sea water will come into contact with the steel of the pipe. Without cathodic protection, the steel of the pipe would rapidly corrode. By positioning suitably spaced galvanic anodes on submerged pipelines, the pipelines may be designed to have a useful life of forty years or more.

5. The subject of the reissue patent in suit is a galvanic anode. Galvanic anodes of different shapes and sizes for land and marine cathodic protection uses have been known for many years. A typical, practical anode is comprised of a body of anodic metal (magnesium, zinc, or aluminum) containing a cathodic metal core which is largely embedded therein. The anodic metal is attached to the iron or steel body in such a way that a small electric current can pass between the anode and the body to be protected.

3. The ASARCO Bulletin 191 Bracelet Anode

6. About 1957 Wayne Broyles, president of defendant Broyles, conceived an idea for an anode which embraced the pipeline and was called a "bracelet". This bracelet anode was composed of a pair of semi-cylindrical members, each comprising a number of arcuate segments of anodic material, usually zinc. Each of the arcuate segments had a steel core which was cathodic to the anode metal extending longitudinally to the pipeline. The core was embedded within the anode metal, and the end portions projected from the opposite ends of the segment and were welded to a pair of semi-circular steel bars not embedded in the zinc, thereby forming one of the semi-cylindrical members. The steel bars conducted current between the pipe and the anode metal and held the anode onto the pipe. The anode segments were tapered on their adjacent sides so that they fitted closely together, and the galvanic anode metal therefore formed two substantially continuous semi-cylindrical

bodies of galvanic anode metal. Such anodes were placed on a pipeline over the protective coating, the exposed steel was coated with protective coating, and the pipeline was then covered with concrete. (Pltf.'s Exhibit 51-A).

This bracelet anode was developed by Broyles and ASARCO and was described in Bulletin 191, entitled "Cathodic Protection of Submarine Pipeline", an ASARCO reprint from Federated Metals Digest, published in 1958. (Pltf.'s Exhibit 18). The Bulletin 191 anode was the first galvanic anode designed to protect submerged pipelines of this size, and from 1958 to 1969, it was the only commercially available and universally employed bracelet anode for underwater pipelines and became the standard anode for such pipelines. The arcuate segments were and still are manufactured substantially exclusively by ASARCO which sells them to its distributors, including defendant Broyles and plaintiff.

7. The Bulletin 191 anode is comprised of eight (8) segments to a bracelet, with four (4) segments to each semi-cylindrical half-bracelet. Assembly and preparation for installation of a Bulletin 191 anode requires four steps. First, individual segment anodes are sent from the foundry to be welded, with four segments welded as a semi-cylindrical unit. The longitudinal core of each segment must then be welded to the external steel band. Second, the welded segments are sent to be assembled for shipping. Third, the anodes are shipped to a pipe coating yard, where they are coated for placement on the pipe. Fourth, the anodes are sent to another location, where they are actually installed on the pipeline.

8. The structure of the core and the design and manner of attachment of the external bands caused several problems in proper handling and use of the Bulletin 191 anode. Between 1958 and 1969, persons in the industry discerned

many disadvantages in the construction and assembly of these anodes. The anodes required numerous welds to secure the cores to the external steel bands, and the external bands were often bent or otherwise disfigured or warped prior to installation, necessitating costly repair jobs at the installation site. (Pltf.'s Exhibits 1A through 1F).

Bulletin 191 anodes free of handling problems were still difficult to install because of the external bands. The coating on the external bands would become damaged prior to reaching the installation site. Further, the structure of the segments and the multiple handling required for installation would occasionally cause individual segments to separate from, or change positions relative to, each other and to the external band.

The exposed steel bands demand current from the anodic metal for their own protection, especially because of their close proximity to the anodic bodies. The current wasted to protect the exposed steel bands, which can be called "parasitic current", may range from 5 percent to 12½ percent of the total current supplied by the anodic bodies and tends to reduce the useful life of the anodic metal, and hence, that of the anode.

The Bulletin 191 anode requires the external bands to support the arcuate segment anodes in proper relationship, to attach the half-bracelets together in pipe-embracing relation, and to conduct sacrificial current from the pipe to the cores of the segment anodes.

4. Ideas Prompting Plaintiff's Invention

9. Plaintiff first attempted to improve on the Bulletin 191 bracelet anode by replacing the arcuate segment anodes with other anodes having cores embedded in the longitudinal direction, i.e., parallel to the pipe's axis, while keeping intact the external bands which constituted the foundation for the anode.

In reality, very little could be done to improve upon the Bulletin 191 design. Adjusting the external band to combat bending and disfigurement was not helpful because such adjustment would only create a larger band with a proportionate increase in the need for parasitic current. Heavier cores would not solve the problem either, since only the manufacturer ASARCO, and not users like plaintiff, could effect this change.

10. Gordon Doremus, working in plaintiff's office, and Jack L. Davis, working as a field engineer, were both intimately acquainted with the deficiencies of the Bulletin 191 design and with its shortcomings in application. Working together on a day-to-day basis, they conceived the idea for the invention embodied in the patent in suit in September, 1968.

The invention sought to obviate the deficiencies of Bulletin 191 by removing the two semi-circular steel bands external to the anode body, by eliminating the need for independent fabricator shops to assemble anodes, by providing bracelet anodes which were not mechanically weak and by completely enclosing the core within the body of the anode metal.

The invention had a preferred embodiment of two semi-cylindrical segments fitted tightly around the pipe. One segment completely encircling the pipe could not be forged to fit properly on the pipe; using more than two segments was feasible, but using fewer segments increased the efficiency with which the anodic material protected the pipe. Using fewer segments also reduced handling and installation costs and the amount of parasitic current required to protect exposed steel. The steel cathodic core was designed to be embedded concentrically within the anode and adjacent to the inner periphery of the anodic body. The invention differed from the Bulletin 191 anode by having cores con-

centric to the pipeline, by having no external bands to secure the anode to the pipe and by reducing the number of segments per bracelet.

B. The Patent in Suit

1. The Original Application

11. Having no prior experience with patent applications or procedures, Doremus and Davis approached Rubin Werlin, a patent attorney in Houston, Texas, to seek his assistance in prosecuting an application for a patent on the instant invention. Werlin, who had no prior experience with galvanic anodes, requested a patent search to be made to ascertain the state of the art in this field. Doremus and Davis examined those patents discovered in the resulting search, but concluded that such patents were not relevant because they did not pertain to the application of cathodic protection of large offshore pipelines. They concluded that the only truly relevant prior art was the Bulletin 191 anode. Werlin agreed with their assessment that the idea probably represented a patentable invention, and he prepared a description of their invention as part of an application for the original patent. (Pltf.'s Exhibit 15).

12. The original application was initially rejected by the Patent Office as unpatentable over Bulletin 191. To the Examiner, plaintiff's invention initially represented a semi-cylinder made of one continuous segment rather than several connected segments. The Examiner did not cite any prior art in rejecting that portion of the invention which described the concentric core having end portions projecting from opposite ends of the anode body, nor did he discuss an essential element of the invention, the embedding of the steel core within the anodic metal.

13. Fearing that his own misunderstanding of the scope of the invention had caused the rejection, Attorney Werlin

discussed with Doremus and Davis possible amendments to the application to enhance its acceptability to the Examiner. The application was therefore amended to overcome the Examiner's objections and included detailed specifications describing the structure and functions of the core. Wording the application in greater detail, the attorney erroneously drew the claim too narrow to emphasize the inventiveness of the core structure and unintentionally restricted the scope of the invention unnecessarily.

14. After examining the highly-detailed amendment and re-evaluating all of the claims, the Examiner reversed his initial conclusion on patentability and approved the application, as amended.

15. The original patent was issued on October 26, 1971, and contained five claims. Claim 1, the only independent claim, read as follows:

> "1. A galvanic anode for cathodic protection of pipelines, comprising:
>
> a) a pair of semi-cylindrical segments adapted to embrace a pipe line, each segment comprising:
>
> 1) a continuous semi-cylindrical body of a galvanic anode metal;
>
> 2) a metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body;
>
> 3) said core having end portions projecting from opposite ends of the anode body for connecting one of said segments to the other in pipe-embracing relation."

16. Claims 2-5 were dependent upon Claim 1 and specified structural details such as the nature of the anode metal (Claim 2), the nature of the core metal (Claim 3), current

conductor elements connected to the core (Claim 4) and the configuration of the end portions of the bars which project from opposite, longitudinal edges of the anode body to form joint elements for connecting one of the semi-cylindrical segment anodes to the other in pipe-embracing relation (Claim 5).

2. The Reissue Application

17. Plaintiff filed its reissue application, Serial Number 277,381 on August 7, 1972, through new counsel, Michael P. Breston, a patent attorney in Houston, Texas, to eliminate unduly restrictive descriptions and cover all elements intended to be covered. With increased exposure to Patent Office procedures and statutory requirements, Doremus and Davis became more aware of how properly to phrase claims and to re-word the patent application so as to express fully the scope of their invention. After October 26, 1971, they became aware that the original patent claimed less than they were entitled to claim because the unnecessary limitations inserted by attorney Werlin expressed only the most desirable design of the invention.

18. The reissue application contained original Claims 1-5 and new Claims 6-14. Claim 6 recites the structure of Claim 1 but without the angularly-spaced metal rods.

> "6. A galvanic anode for cathodic protection of pipelines, comprising:
>
> (1) a continuous, semicylindrical body of a galvanic anode metal;
>
> (2) a metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body;
>
> (3) said core comprising:
>
> (a) at least two axially-spaced, metal bars; and

> (b) each of said bars having end portions projecting from opposite, longitudinal edges of the anode body to form joint elements for connecting one of said segments to the other in pipe-embracing relation."

19. Claim 7 recites the structure of Claim 6, but, whereas Claim 6 requires a pair of semi-cylindrical segment anodes, Claim 7 requires a pair of arcuate segment anodes. Claim 9 is similar to Claim 2; Claim 10 is similar to Claim 3; Claim 11 is similar to Claim 4; and Claim 12 is similar to Claim 5.

20. Claim 13 calls for a plurality of arcuate segments instead of a pair of arcuate segments.

> "13. A galvanic anode for cathodic protection of pipelines comprising:
>
> a plurality of arcuate segments adapted to embrace a pipeline, each segment comprising:
>
> (1) a continuous, arcuate body of galvanic anode metal;
>
> (2) a metal core cathodic to the anode metal concentrically and entirely embedded within the anode metal adjacent the inner periphery of said body;
>
> (3) said core comprising:
>
> (a) at least two, axially spaced-apart metal bars;
>
> (b) each of said bars having end portions projecting from the opposed longitudinal edges of the said segments to form joint elements for connecting said segments to each other in pipe-embracing relation."

21. Claim 14 is dependent upon Claim 13 and requires at least one interlinking metal rod between core bars.

22. In the Patent Office the entire reissue patent application, including the reissue oath, Claims 1-14, and the additions and deletions to the specification, was subjected to a complete examination *de novo* by the same Examiner who examined the original patent application. The Examiner reallowed all the original claims 1-5 and new Claim 6, which eliminated the interlinking rods from Claim 1. The Examiner rejected the new Claims 7-14 as unpatentable over Bulletin 191 and other prior art of record in the original patent and as being "new matter".

23. The inventors and Attorney Breston re-stated their position fully to the Examiner in person and filed an amendment eliminating all extraneous details. (Pltf.'s Exhibit 17). They made no misrepresentations to the Examiner to obtain the reissue patent. Upon re-evaluation, the Examiner concluded that he had erred in perceiving the scope of the invention and decided to approve the amended reissue application in full. The reissue patent was issued on December 12, 1972. (Pltf.'s Exhibits 17, 49, 50).

3. The Essence of Invention Embodied in the Reissue Patent

24. Plaintiff's invention is essentially a bracelet anode of the type which completely encircles a pipe and which comprises two or more arcuate anode bodies, each having an entirely embedded, concentric, cathodic-metal core, adjacent to the inner periphery of the anode body, with the core having end portions which project from opposite longitudinal edges of the anode body.

25. Plaintiff has completely eliminated the exposed, external steel bands required by the Bulletin 191 anode and has replaced the longitudinal cores in the plurality of segment anodes with a concentric, fully-embedded core preferably consisting of two spaced-apart concentric metal bars. Each concentric bar serves both prior art functions for

which the longitudinal cores and the concentric external steel bands were previously used.

26. The original patent application, as filed, contained no single claim specifically commensurate in scope with the above-mentioned objects of the invention and contained no single claim which encompassed the essence of plaintiff's invention. Original Claim 1, as filed, did describe a concentric metal core but was limited to a pair of semi-cylindrical segments with interlinking metal rods.

27. The semi-cylindrical form is the best form, or "preferred embodiment," of the invention. Increasing the number of segments per bracelet increases the total amount of exposed steel needed to connect the anode segments, thus potentially increasing the amount of parasitic current consumed. However, the invention still resolves many former application problems with a configuration of a plurality of segments, and Original Claim 1 therefore unnecessarily limited the scope of the invention to semi-cylindrical bracelets.

28. Two or more interlinking metal rods within the core are desirable but not essential to the anode. The large embedded concentric straps (Pltf.'s Exhibit 50-A) are the key elements of the core. The anodic current flows primarily from the longitudinal ends of the anode, not from the center. Therefore, the last remaining bit of anodic metal to be consumed comprises a "ring" around the straps. To extend the life of the anode as long as possible, the anodic metal must maintain contact with the straps, and the interlinking rods do contribute slightly to the durability of the anode by enhancing contact between anodic and cathodic metals. Presence of the interlinking rods therefore prolongs but is not essential to sustaining the useful life of the anode.

29. The error made by plaintiff in not presenting sufficiently broad claims in its application as originally filed arose in good faith without any deceptive intention, and the reissue application and reissue oath fully complied with the requirements of the law, 35 U.S.C. § 251, Rules 171-175 of the Rules of Practice before the Patent Office, Section 1401.07 of the Manual of Patent Examining Procedure and 35 U.S.C. § 112. Considering the nature of the subject matter of this invention, no new matter was introduced into the reissue patent by the additions to and deletions from the original patent. The inventions described in the original and reissue patents are identical.

30. Plaintiff has complied with Rules 56-57 and with Sections 605.04 and 605.04(a) of the Manual of Patent Examining Procedure. The applicants have signed the oath "attached to a complete application", as required by the single signature form 16 of the Rules. The claims added by the reissue patent are proper claims. Any amendment to the original claims which proved to be unduly restrictive was made in error, without deceptive intent.

31. Plaintiff's conduct does not merit invocation of the doctrines of file wrapper estoppel, collateral estoppel, or res judicata.

32. Jack G. Davis was a joint inventor of the patent in suit. Gordon L. Doremus and Jack G. Davis have been closely associated in marine cathodic protection work since 1954. They worked together for several years, first in an attempt to improve on the ASARCO bracelet anode and then to develop a different bracelet anode. The assignment of responsibilities and the performance of work tasks in plaintiff's office dictated that all work problem solving was achieved by interrelated efforts. Doremus contributed technical knowledge to the conduct of day-to-day business affairs, while Davis contributed applied knowledge through

extensive experience in the field. The work product was the result of joint interdependent efforts. Segregating the individual contributions of two such men who possess extraordinary skill in the art in such a working environment is neither warranted by the evidence nor feasible. Jack G. Davis was a co-inventor of the original patent and the reissue patent. The joinder of inventors was made in good faith.

C. The Prior Art

1. Novelty, Anticipation, Obviousness

33. The patented bracelet anode discussed in the patent in suit is a basic invention whose novel simplicity should not be mistaken for imitation of prior art or obvious improvements upon prior art. In the insular world of cathodic protection of large offshore pipelines, plaintiff's novel invention is not anticipated by any prior art, and nothing in any prior art patent or combination of patents enables a person skilled in the art to construct plaintiff's invention. Without utilizing the teachings of plaintiff's patent, such a person could not rely solely upon the teaching of prior art patents to combine or modify such patents in the manner disclosed in the instant suit. Indeed, utilizing such prior art, especially the most pertinent prior art, the Bulletin 191 anode, persons in the industry looked toward use of stronger external bands as the next trend in development. Plaintiff's design of arcuate segment anodes having entirely embedded concentric cores radically departs from this trend.

34. A review of the prior art cited by defendants to plaintiff, pursuant to 35 U.S.C. § 282, or to this Court, reveals the lack of relevance or materiality of such art, and demonstrates that because of the nature of the invention and the usage requirements in the industry, only the Bulletin 191 anode is pertinent. Plaintiff's refusal to cite

as pertinent other prior art than Bulletin 191 to the Patent Examiner in submitting the applications for the original and reissue patents is therefore of no consequence.

2. Prior Art Cited by Defendants

a. The Mills Patent

35. The patent to Mills, No. 1,664,800, issued April 3, 1928, discloses semi-cylindrical anodes for a pipeline to be buried below ground. Mills discusses the electrochemical causes of corrosion in such circumstances and describes the electropositive impact which anodic metals generate when placed in close proximity to buried pipelines to combat this corrosion.

The patent to Mills does disclose use of arcuate anode segments for installation onto the pipe. However, the patent is not designed for use in submerged pipelines, does not require use of core to promote even distribution of current on the pipeline and even consumption of the anodic metal, is vague in its description of the core and does not disclose any particular means by which to secure the anode to the pipeline.

b. The Godfrey Patent

36. The patent to Godfrey, No. 2,067,839, issued January 12, 1937, discloses a cylindrical boat propeller shaft anode. Godfrey declares the objects of his invention to be prevention of corrosion to boat propellers, propeller shafts, etc., by attaching an anode to the part requiring protection in such a manner as to ensure the durability of the anode attachment to the protected area.

The patent to Godfrey does disclose an anode comprised of two semi-circular sections. However, *the scale on which such anodes are to be used does not present the problems*

of installation or durability encountered in the instant application. Further, the Godfrey patent provides for the use of nonmetallic cores which are not completely embedded in the anode. Both of these attributes are vital to a bracelet anode of the size and use contemplated in the instant case. The Godfrey patent appears to be unsuited for such use because of the necessity of exposing a relatively large area of core to sea water. Finally, the type of mechanical connections required by the Godfrey patent would be inappropriate in a pipeline application, which would more likely require welded or brazed connections.

c. The Wesley Patent

37. The patent to Wesley, No. 2,303,778, issued December 1, 1942, discloses a soil pipe of composite ferrous layers designed to prevent corrosion. Wesley's patent is designed to promote uniform consumption of the pipe metal and to retard perforations caused by localized corrosion. The invention provides a design to protect against corrosion exposure to one side of the pipe, or to all sides.

The patent to Wesley does disclose a means of combatting underground corrosion electrochemically, and plaintiff did cite this prior art to the Patent Examiner in its application for the reissue patent. However, the patent does not disclose a bracelet but rather an envelopment of whole sections of pipe with layers of anodic materials. The difficult problems of attaching bracelet anodes to offshore pipelines and enhancing the durability of the anode with a core construction are not confronted or discussed. Indeed, support for the anodes is not a land, but only a marine, problem.

d. The Harris Patent

38. The patent to Harris, No. 2,619,455, issued November 25, 1952, discloses a galvanic anode with a wire core, being

separated into segments held together by the core, for use in protecting iron tanks. The patent is designed to overcome the difficulty of installing anodic rods in previously erected tanks or receptacles. The seminal feature of the patent is its rod-like anode with a flexible metallic core embedded lengthwise in the body of the anode.

The patent to Harris does disclose a co-axial wire core completely embedded in the anodic material. However, the anode has longitudinally spaced-apart notches to be broken into segments to permit formation of a polygon and is not designed to combat the problems of scale and durability which bracelet anodes must overcome. The segments are not arcuate, and the patent does not disclose any rods which cross-link core bars.

e. The Osterheld Patent

39. The patent to Osterheld, No. 2,656,314, issued October 20, 1953, discloses a means of combatting corrosion in hot water storage tanks. The patent is designed to provide insertion of a sacrificial anode inside the tank which will uniformly protect the tank and also dissociate at a controlled uniform rate.

The patent to Osterheld does disclose a connection from the anodic to the cathodic metal, and plaintiff did cite this prior art to the Patent Examiner in its application for the reissue patent. However, credible evidence at trial demonstrated that the Osterheld patent bears only small relationship to the reissue patent, especially with regard to the scale of the former anode and its lack of reference to a bracelet application.

f. The Sabins Patent

40. The patent to Sabins, No. 2,826,543, issued January 31, 1955, discloses a sacrificial magnesium anode with insu-

lation to prevent premature disintegration of the anode by localized galvanic action. The patent features laterally spaced, longitudinally extending core rods connected by cross-linking rods in the core structure, making use of magnesium as the preferred anodic material.

The patent does disclose an anode with internal core that is intended for marine use. However, such use would be limited to so-called hull structures, because of the absence of arcuate design. The patent is not relevant to a bracelet anode application for a pipeline.

g. The Douglas Patent

41. The patent to Douglas, No. 2,882,213, issued on April 14, 1959, discloses a galvanic anode designed for marine use. Douglas declares that the principal object of the patent is to increase the useful life of the anode. The patent is also designed to eliminate the need of insulating the anode from the cathodic surface and to control the manner and uniformity of the rate of anode consumption in various parts of the anode body.

The patent does disclose an anode with embedded core material and longitudinal edges with ends projecting from either side. However, the patent is rectangularly shaped with no arcuate design and is intended to be used principally as a hull anode. Moreover, the patent utilizes a laminated covering around the anode for insulation purposes which differs from the type of coating required for the reissue patent. No concentric core structure is shown.

h. The Battis Patent

42. The patent to Battis, No. 3,001,924, issued September 26, 1961, discloses a galvanic anode comprised of magnesium to which an electrical conductor is connected. The principal object of the patent is to counteract the accelerated local

corrosion of anode brackets which causes an anode to break loose from its brackets. The patent discloses a plug of metal, cathodic to magnesium (such as zinc or aluminum) but anodic to the ferrous metal conductor which protrudes from either end of the anode.

The Battis patent does disclose an embedded conductor with external straps extending from the sides of the anode. However, the anode is rectangular, lacks an arcuate design and is useful primarily as a ship hull anode. The patent also does not disclose usage of internalized core rods pertinent to the instant application and requires usage of two sets of anodic material within the core.

i. The Fairchild Patent

43. The patent to Fairchild, No. 3,197,262, issued on July 27, 1965, discloses a pipe protector adapted for use with drill pipe sections. The protector is designed to protect the pipe and the drill string from excessive rubbing against the casing and to permit flexible longitudinal movement of the protector along the pipe.

The patent discloses placement of a bracelet around a drill pipe but has no relation to cathodic protection and does not contemplate potential problems of design and placement of bracelet anodes on offshore pipelines. Further, the pertinent core design is not discussed.

j. The Pennington Patent

44. The patent to Pennington, No. 3,240,512, issued on March 15, 1966, discloses a conduit construction and weight means for underwater pipelines. The patent is primarily designed to improve methods and structures for joining together adjacent conduit sections of underwater pipelines and to improve means of weighting such sections.

The patent does disclose a sleeve for underwater pipelines having two or more arcuate segments, each segment comprising a continuous arcuate body of concrete, with a metal core concentrically embedded entirely within the concrete adjacent to the inner periphery of the body. However, the specific core design is not disclosed in the patent, nor are straps or other materials used to facilitate a welded or brazed connection to the pipe. Further, the metal base fits snugly on and directly against the pipe, contrary to the teaching of the reissue patent.

k. Military Hull Anode

45. The military specification (MIL-A18001-H) cited by defendants (Defts.' Exhibit 12) discloses ship hull anodes with straps extending from either end of the anodic body. The design does not disclose completely embedded concentric cores and bears the same difficulty of adjustment to bracelet pipeline use as do the previously referenced patented hull anodes.

l. The LL-26 Anode

46. The final prior art introduced at trial was an anode designed by J. L. Andrews in 1965 and known as an "LL-26" anode. *See* Defts.' Exhibit 11. The LL-26 flat anodes are standard ASARCO, hull type, zinc anodes bent to a ten-inch radius. The 1965 drawing shown in Defts.' Exhibit 11 depicts two LL-26 anodes attached to a fairwater cone of an ocean-going tug. The LL-26 anode was first heat-treated and then bent under great pressure causing its core to become adjacent to the outer, or external, arcuate periphery of the anode. The bent anodes were mounted in two diametrically-opposite grooves cut for that purpose in the outer wall of the fairwater cone. The LL-26 anode's core consisted of a bar of steel with end portions projecting from the opposite longitudinal ends of the anode body.

These end portions were welded to the external conical wall surface of the fairwater cone. The total circumferential length of the anode bodies of the two diametrically-opposed bent anodes was sustained by an angle less than 180°.

The LL-26 anode does disclose concentrically extending cores embedded within the anodic body. However, the overall design of the LL-26 anode, as well as the circumstances prompting its creation and its manufacture, all combine to demonstrate that the LL-26 anode is not a relevant reference to the prior art.

The LL-26 anode is a flat anode which was bent to fit onto a cone. The anode does not have an arcuate design and was not adapted at any time to embrace a pipe, nor designed to be manufactured to embrace a pipe. The anode requires making grooves in the wall of the cathodic body for installation and attachment, and such grooves cannot be made in the wall of a pipeline. While the end portions of the core bar do protrude beyond the anode, nothing in the design or adapted use of this anode suggests that the end portions were intended to be, or could be, interconnected to form joint elements of a pipe-embracing anode. The only intended use of this anode was as an individual anodic body, separately secured to a cone according to conventional practice.

Additionally, the manner in which the anode was altered to meet one customer's specifications, then abandoned and thereafter never published or otherwise developed, compels its elimination from consideration as a branch of prior art.

3. Conclusion Regarding Prior Art

47. The Court has carefully evaluated all of this prior art and compared it to the design and use to which the instant invention is put. Nothing in the prior art demonstrates that the elements utilized in plaintiff's patent were

ever used or taught as claimed and intended to be used in that patent prior to its invention. For purposes of patentability, the only significant prior art was the Bullentin 191 anode. As noted above, *see* Finding of Fact No. 34, *supra,* plaintiff's failure to cite other art is of no consequence; and plaintiff's continued prosecution of this suit has been proper in view of the lack of pertinence of other prior art than Bulletin 191. Plaintiff did not misrepresent to the Patent Examiner the state of the prior art and met the requirements of honesty and good faith disclosure required by law in filing and prosecuting both the original and reissue applications.

48. Against the background of the scope and content of the prior art and the level of ordinary skill in the art, the claimed subject matter of the patent in suit was not obvious to a man of ordinary skill in the art at the time the invention was made and was not anticipated by prior art, whether the prior art asserted is taken singly, or in combination.

D. Patent Validity

1. Other Evidence of Patentability

49. The findings of novelty, non-obviousness and no anticipation are reinforced by objective evidence. Since the first sale of plaintiff's patented anodes in 1969, the demand for them has been steadily increasing with major domestic and international oil companjes having worldwide operations. The average annual sales of this anode by plaintiff alone have totaled $250,000 in spite of a shortage of the zinc used to make the anodes; defendants have also sold a substantial number of the patented anodes. While plaintiff has continued to offer Bulletin 191 anodes for sale, few buyers have remained interested in them; sales of the patented anode have practically eliminated sales of the Bulletin 191 anode.

Defendants attempted to invent, develop and produce a non-infringing bracelet anode to deflect plaintiff's expanding anode business. Defendant ASARCO expended more than three years of design effort before deciding to produce the accused anodes, which now occupy a considerable portion of its bracelet anode production.

2. Conclusion

50. Plaintiff's invention introduced to the oil and gas pipeline industry a bracelet anode that was strong, easy to install on the pipe and capable of providing maximum current efficiency for cathodic protection. Such bracelet anodes maintained their structural integrity during shipping and handling and reduced to a minimum the number of welds required for the assembly of a complete bracelet anode. The patent in suit is novel, non-obvious and is not anticipated in the prior art nor capable of imitation by a person of ordinary skill in the art. The patent in suit is therefore valid.

E. Infringement

1. Copying of Plaintiff's Design

51. Plaintiff has carried its burden of proving infringement. Defendants viewed plaintiff's bracelet anode as a serious threat to ASARCO's virtual monopoly of the bracelet anode market. Defendants' engineering and sales departments came to evaluate plaintiff's new galvanic bracelet anode carefully between 1969 and 1971. For example, ASARCO employees R. E. Baxter and Paul Smith made an inspection of the new anode at pipe yards in New Orleans, Louisiana, and Galveston, Texas, respectively. Both took measurements of the anode and filed reports with ASARCO favorably commenting upon it. ASARCO made extensive drawings, technical descriptions, photographs and sketches showing the construction of plaintiff's

invention. (Pltf.'s Exhibits 8-12). Plaintiff's anode was much discussed at ASARCO. (Pltf.'s Exhibits 23-C, 23-D, 23-E, 23-F, 23-G, 23-H, 23-I, 23-J, 23-M).

52. In 1969, ASARCO built a bracelet anode from a pair of semi-cylindrical segment anodes. (Pltf.'s Exhibit 23-A). ASARCO then switched to quarter-circle bracelet anodes. ASARCO induced Broyles to offer them for sale. Broyles made a drawing early in 1972 of a bracelet anode consisting of four quarter-circle segments based on the ASARCO design (Pltf.'s Exhibit 10), each segment including angularly-spaced metal rods interlinking with the two concentric bars. In February, 1972, Broyles successfully offered this product for commercial sale to a customer in direct competition with plaintiff's invention, and the customer chose the accused device over the Bulletin 191 anode. The accused device depicts the angularly spaced-apart, interlinking, small-diameter metal rods.

53. Defendants have made and sold three types of bracelet anodes which are accused of infringement. Type A was first sold after the issue of the original patent in 1971 and before the application for reissue was filed. Types B and C were made and sold after December 12, 1972, the issue date of the reissue patent.

54. The accused bracelet anodes have the following features: four (or eight in the case of Type B) arcuate segment anodes adapted to embrace a pipeline, with each segment having a continuous, arcuate body of galvanic anode metal, a cathodic metal core concentrically and entirely embedded within the anode metal adjacent to its inner periphery and comprised of either one single bar (Types B and C) or two axially-spaced apart metal bars (Type A). All types have the end portions of the bars projecting from opposed longitudinal edges of the segments to form joint elements for connecting segments in

pipe-encircling relation. (Defts.' Exhibits 17, 18, 33, 34, and Pltf.'s Exhibits 3A through 3E, 11 through 13 and 52).

2. Infringement of Claims 1-5

55. The Type A bracelet anode has substantially the same structure and functions in substantially the same manner to accomplish essentially the same result as plaintiff's semi-cylindrical bracelet anode. Claims 1 through 5 describe the Type A bracelet anode: the bars are embedded entirely within each arcuate segment anode and are adjacent to the accused anode's inner periphery; and the end portions of the bars are configured identically to the design in the claims. The accused Type A bracelet anode is severed into two pairs of segment anodes, i.e., does not have a continuous semi-cylindrical anode body and does not include interlinking rods. However, the methods of operation, assembly and function of the Type A bracelet anode are in all material respects the same as those of the patented bracelet anode. The differences are minor, and Claims 1-5 themselves contemplate each aspect of the design of the accused Type A bracelet anode.

56. Defendants therefore infringe Claims 1-5 of the original and reissue patents by making and selling the Type A bracelet anode.

57. In addition to distinctions between the Type A anode and the patented anode noted above, the Types B and C bracelet anodes contain only a single concentric bar instead of two axially-spaced apart bars. Nevertheless, the components of the accused Types B and C anodes fall within the scope of Claims 1-5, substantially for the same reasons given relative to the Type A bracelet anode, and further because combining two concentric bars into a single bar does not avoid infringement of the reissue patent.

58. Defendants therefore infringe Claims 1-5 by making and selling the Types B and C bracelet anodes.

3. Infringement of Claims 6, 7 and 9-13

59. The Types A, B and C bracelet anodes have more than one pair of segment anodes and the semi-cylindrical anodic body is discontinuous. However, severing one segment into two or more segments, or combining two concentric bars into one bar does not take the accused anodes beyond the scope of the instant invention nor avoid infringement. Defendants infringe Claim 6, which is identical to Claim 1 except for the "rods" limitation by producing and selling their Types A, B and C bracelet anodes in competition with the patented anode described in the reissue patent.

60. Claims 7 and 9-12 are similar to Claims 6 and 2-5, respectively, except that Claim 7 requires "a pair of arcuate segments" instead of "a pair of semi-cylindrical segments," as in Claim 6. Claim 13 is identical to Claim 7, except that Claim 13 calls for "a plurality" of such segments, whereas Claim 7 calls for "a pair of segments".

61. The Type A bracelet anode literally infringes Claims 7 and 9-13. The Types B and C bracelet anodes are the full equivalents of the subject matter claimed in Claims 7 and 9-13; combining two concentric bars into one does not avoid infringement. Manufacture and sale of the Types A, B and C bracelet anodes therefore infringe Claims 7 and 9-13.

4. Conclusion

62. ASARCO has infringed Claims 1-7 and 9-13 of the reissue patent by manufacturing the accused anodes. ASARCO has infringed Claims 1-7 and 9-13 of the reissue patent by actively encouraging and inducing Broyles to

infringe and by granting Broyles a patent infringement indemnity. ASARCO has contributorially infringed Claims 1-7 and 9-13 of the reissue patent by offering to Broyles two or more pairs of segment anodes for assembly into one pair of semi-cylindrical segment anodes adapted to embrace a pipeline. The arcuate segment anodes, as manufactured by ASARCO with the concentric cores as specified in the claims of the reissue patent, are not staple articles of commerce suitable for non-infringing use.

Broyles has infringed Claims 1-7 and 9-13 by acting alone and in concert with ASARCO to assemble and sell the accused anodes in competition with the patented anode.

63. Defendants' conduct evidences a program to eliminate plaintiff as a potential competitor by: (1) offering "advantageous" prices for the old ASARCO Bulletin 191 bracelet anodes to Broyles and other competitors of plaintiff; (2) refusing to sell zinc to plaintiff for the making of its patented anodes; and (3) offering to defendant Broyles a blanket "hold harmless" indemnity against liabilities arising out of defendant Broyles' infringement of the patent in suit.

II. CONCLUSIONS OF LAW

A. Jurisdiction and Venue

1. This matter arises under the Patent Statutes of the United States, and exclusive subject matter jurisdiction is proper in this Court. 28 U.S.C. § 1338(a). Venue is properly laid in this District. 28 U.S.C. § 1400(b). The defendants have regular and established places of business here, and acts charged as infringements have taken place within this District.

2. Plaintiff Cathodic Protection Service (CPS) is the owner of the Doremus patent in suit and has standing to

bring and maintain this action. Gordon L. Doremus and Jack G. Davis were co-inventors of both the original and reissue patents.

B. Validity of the Patent

3. All patents lawfully issued by the Patent Office enjoy a presumption of validity. 35 U.S.C. § 282. The burden of establishing invalidity rests upon the party asserting it, and although the presumption is rebuttable, the challenger bears a heavy burden of proof. *Ingersoll-Rand Co.* v. *Brunner & Lay, Inc.*, 474 F.2d 491, (5th Cir.), *cert. denied*, 414 U.S. 865 (1973); *Beckman Instruments, Inc.* v. *Chemtronics, Inc.*, 439 F.2d 1369, 1374-75 (5th Cir.), *cert. denied*, 400 U.S. 956 (1970). However, failure to present or cite pertinent prior art to the Patent Office weakens the presumption of validity. If the evidence discloses that the Patent Examiner was not shown or did not consider pertinent prior art during the prosecution of the application, the presumption of validity is more easily overcome. *Garrett Corp.* v. *American Safety Flight Systems, Inc.*, 502 F.2d 9 (5th Cir. 1974); *AG PRO, Inc.* v. *Sakraida*, 474 F.2d 167, 172 (5th Cir. 1973).

4. The three germinal tests of patent validity are utility, novelty and nonobviousness. 35 U.S.C. §§ 101, 102, 103; *Graham* v. *John Deere Co.*, 383 U.S. 1 (1966); *Gaddis* v. *Calgon Corp.*, 506 F.2d 880 (5th Cir. 1975). Each of these three conditions must be satisfied if the patent is to be held valid. *Graham* v. *John Deere Co., supra*, 383 U.S. at 17.

5. A patentable invention must be useful. 35 U.S.C. § 101. A patented invention is useful if it is capable of performing a beneficial function claimed for it. *Smith* v. *Nichols*, 88 U.S. 112 (1875); *Seymour* v. *Osborne*, 78 U.S. 516 (1871). The patented invention need not function flawlessly in all situations, but it must be capable of a practical

application in industry. *Eastern Rotocraft Corp.* v. *United States,* 384 F.2d 429, 431 (Ct. Cl. 1967); *Curtiss-Wright Corp.* v. *Link Aviation, Inc.,* 182 F. Supp. 106, 123 (N.D. N.Y. 1959). Utility must be determined as of the date of invention. *Id.*

6. Section 102, which pertains to novelty, requires that the patentee be the original inventor of the object claimed in his patent and also that the invention not have been known or used by others before his discovery of it. *Beckman Instruments, Inc.* v. *Chemtronics, Inc., supra,* 439 F.2d at 1375.

7. While the ultimate question of patent validity is one of law, the Section 103 condition of nonobviousness lends itself to several basic factual inquiries. *Graham* v. *John Deere Co., supra.* Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved.

Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy. *Graham* v. *John Deere Co., supra,* 383 U.S. at 17.

8. The defendants have failed to carry their burden of rebutting the presumption of validity or of demonstrating the invalidity of this patent. The presumption of validity therefor remains in full force and effect in this case.

9. Both plaintiff's original patent (3,616,422) and its reissue patent (Re 27,529) were duly and regularly issued in accordance with 35 U.S.C. §§ 102, 103 and 251. *See* Findings of Fact ## 11 thru 14, 17, 22, 23, 29 and 30, *supra.* The original application was properly signed by the applicants Doremus and Davis, 35 U.S.C. §§ 111, 115; Finding of Fact #30, *supra,* and both persons were properly joined as inventors of the patent. 35 U.S.C. § 256; Finding of Fact #32, *supra.*

10. Plaintiff's refusal to cite to the Patent Examiner other art than the Bulletin 191 anode as fundamentally pertinent prior art is of no consequence in this case. *See* Finding of Fact #47, *supra.* Plaintiff engaged in no inequitable conduct and practiced no fraud in failing to bring to the attention of the Patent Examiner such other prior art, and this failure in no way affects the validity or enforceability of the patent as reissued. Plaintiff did not misrepresent to the Patent Examiner the superiority of its anode design. Thus, the overall description of plaintiff's conduct in prosecuting its patent in this case in no way reveals the type of conduct found in *Beckman Instruments, Inc.* v. *Chemtronics, Inc., supra.* Plaintiff has not conducted itself in this case so as to prompt a weakening of the presumption of validity.

11. The reissue patent in suit is valid under Section 101. The patent has been extensively utilized in offshore marine pipeline transportation of oil and gas and is extremely useful in facilitating long-term offshore exploration for oil and gas.

12. The reissue patent in suit is valid under Section 102. *The simplicity of this patent should not be confused with hindsight or imitation. The efforts of Gordon Doremus and Jack Davis to resolve significant problems facing users of galvanic anodes for large, submerged offshore pipelines produced an invention not anticipated in the prior art and radically different from anything being used at the time of the invention to afford cathodic protection.*

All prior art cited by defendants other than the Bulletin 191 anode, *see* Findings of Fact ## 35 thru 46, *supra,* exhibit elements of anodic use or design which are analogous to elements of the reissue patent in suit. However, none of these elements had even been used before in this combination, application and magnitude. *Topliff* v. *Topliff,* 145 U.S. 156, 161 (1892). *Plaintiff's invention is the first galvanic anode of its type that utilizes a core embedded concentrically with at least one metal bar and in arcuate form for cathodic protection of this magnitude.*

13. The reissue patent in suite is valid under Section 103. The simplicity of plaintiff's invention should not be confused with obviousness. Applying the *Graham* standards to the instant patent, 383 U.S. at 17, *see* Conclusion of Law #7, *supra,* and carefully evaluating the scope and content of the prior art, *see* Findings of Fact ## 35 thru 46, *supra,* the Court concludes that nothing in the prior art demonstrates that the elements utilized in plaintiff's patent were ever used or taught as claimed and intended to be used in that patent prior to its invention. Finding of Fact #47, *supra.*

14. The only relevant prior art is ASARCO's Bulletin 191 anode. This anode was used exclusively within the cathodic protection industry in the decade prior to plaintiff's invention, and plaintiff's invention is not obvious in light of that prior art. Credible evidence at trial demonstrated that the "obvious" solution to the problems encountered in employing Bulletin 191 anodes was to develop stronger external bands on the outside of the anode to secure it more firmly to the pipe. Finding of Fact #33, *supra.* A person of ordinary skill in the art would have contemplated solving the problems of the Bulletin 191 anode in this fashion and would not have envisioned embedding the core and shifting its axis to perform a

double function, nor utilizing the preferred semi-cylindrical embodiment. Secondary considerations support a finding of validity because of nonobviousness of invention. *See* Finding of Fact #49, *supra.* The long-standing need to overcome the defects of the prior art and the acclaim accorded to the patent in suit upon its introduction in the industry are such considerations that support validity. *Amerace Esna Corp* v. *Highway Safety Devices, Inc.,* 330 F Supp. 313, 318 (N.D. Tex. 1971).

C. Doctrine of Equivalents; File Wrapper Estoppel

15. A device may violate the protection accorded to the invention by performing substantially the same function as the patented invention in substantially the same way to obtain the same result. *Sanitary Refrigerator Co.* v. *Winters,* 280 U.S. 30, 42 (1929). The essence of this doctrine, the doctrine of equivalents, is that one may not practice a fraud on a patent. *Graver Tank Co.* v. *Linde Air Prod. Co.* 339 U.S. 605, 608 (1950).

16. The nature of the invention determines the breadth of its protection under the doctrine of equivalents. An inventor is entitled to a range of equivalents commensurate with the scope of his invention. *Ziegler* v. *Phillips Petroleum Co., supra,* 483 F.2d at 869 *citing American Seating Co.* vs. *Southeastern Metals Co.,* 412 F.2d 756 (5th Cir. 1969). If the invention is broad and primary in its character, the range of equivalents will be correspondingly broad under the liberal construction which the courts give to such inventions. *Continental Paper Bag Co.* v. *Eastern Paper Bag Co.,* 210 U.S. 405, 414 (1908) *citing Miller* v. *Eagle Mfg. Co.,* 151 U.S. 186, 207 (1948).

17. The broadest protection under the doctrine of equivalents is reserved for "pioneer" or "generic" patents. Such patents are those covering a function never before per-

formed, a wholly novel device, or one of such novelty and importance as to mark a distinct step in the progress of the art, as distinguished from a mere improvement or perfection of what had gone before. *Ziegler* v. *Phillips Petroleum Co., supra,* 483 F.2d at 870 *citing Westinghouse* v. *Boyden Power Brake Co.,* 170 U.S. 537, 561-62 (1898). Where the court is confronted with a pioneer patent, liberality becomes the keynote of construction. *Ziegler* v. *Phillips Petroleum Co., supra,* 483 F.2d at 870.

18. The application of the doctrine of equivalents can be curbed by appropriate invocation of the doctrine of file wrapper estoppel. *Banning* v. *Southwestern Bell Tel. Co.,* 384 F. Supp. 831, 838 (S.D. Tex. 1974). An invention must be construed not only in the light of its claims but also with reference to its file wrapper or prosecution history in the Patent Office. *Graham* v. *John Deere Co., supra,* 383 U.S. 1. If the file wrapper reveals that the patentee has surrendered claims, or has amended, narrowed, or otherwise limited his claims in response to the objections of the Patent Office, he may not later recapture through the doctrine of equivalents what he has given up. *Id.*

19. Plaintiff's patent qualifies as a pioneer patent. The invention of Doremus and Davis possesses the characteristics of novelty and importance so as to mark a distinct step in the progress of the art and to offer for the first time since 1958 a viable alternative to the Bulletin 191 anode. See Findings of Fact # # 9, 10, 24 and 25, *supra.* A liberal construction of the breadth of the patent's scope is therefore appropriate under the doctrine of equivalents.

20. Invocation of the doctrine of file wrapper estoppel to curb application of the doctrine of equivalents is not appropriate in this case. Finding of Fact #31, *supra.* Plaintiff did not surrender or otherwise narrow its claims knowingly in response to the objections of the Patent Examiner when

prosecuting the original and reissue applications. On the contrary, plaintiff erred in prosecuting the original application without full appreciation of its breadth. Finding of Fact #29, *supra.* Any alleged defect in the claims of the original patent arose only through error without any deceptive intention. 35 U.S.C. § 251. Plaintiff failed to expand properly its allowable claims until it re-prosecuted the reissue application. Such failure derived solely from this error and from the misconception of the scope of the invention committed by Attorney Werlin when first prosecuting the original application. 35 U.S.C. § 251; *In Re Wadlinger,* 496 F.2d 1200 (C.C.P.A. 1974); *see* Finding of Fact ## 13 and 17, *supra.*

21. Plaintiff did not introduce new matter into the scope of its invention in prosecuting the reissue application in the Patent Office. 35 U.S.C. § 251. The validity of the original claims and claims 6 thru 14 of the reissue patent is not affected by the manner in which Plaintiff prosecuted either the original or the reissue applications. What is covered by the reissue patent was intended to have been covered and secured by the original patent.

22. In short, plaintiff did not limit its claims in the original application and seek thereafter to revive them in prosecuting the reissue application, nor did plaintiff limit its claims before the Patent Examiner in the overall prosecution of the patent, and then attempt to recapture those limitations before this Court by seeking a broader construction of its claim through utilizing the doctrine of equivalents. *Schriber Co.* v. *Cleveland Trust Co.,* 311 U.S. 211, 220-21 (1940) *cited in Banning* v. *Southwestern Bell Tel. Co., supra,* 384 F. Supp. at 838.

Thus, for example, plaintiff is not estopped from construing Claims 1-5 of the original patent to be broad enough to cover bracelet anodes without interlinking rods because

of having given up such coverage in prosecuting the original application.

D. Infringement

23. The question of infringement of a patent is a question of fact. *Ziegler* v. *Phillips Petroleum Co.*, 483 F.2d 858, 867 (5th Cir. 1973). Infringement requires identity of structure, mode of operation and results accomplished. *Id.* at 868.

24. Plaintiff's patent is valid and enforceable and has been infringed by the introduction into the industry of various devices manufactured or sold by the defendants. 35 U.S.C. § 271(a); *e.g.*, Finding of Fact #52, *supra*.

25. Defendants made and sold several types of anodes which are accused of infringement, including anodes with quarter-circle anode segments, one-eighth-circle anode segments, and quarter- and eighth-circle segments assembled into half bracelets, as described in Finding of Fact #54. (Pltf.'s Exhibits 13, 17, 23-A, and Dfts.' Exhibits 33 and 34).

26. The assembly and sale by Broyles of four- and eight-segment galvanic anode bracelets constitute infringement of Claims 1-7 and 9-13 of the reissue patent. ASARCO actively induced Broyles to infringe upon plaintiff's patent, Finding of Fact #63, *supra*, and ASARCO is therefore liable as an infringer. 35 U.S.C. § 271(b).

The manufacture and sale by ASARCO to Broyles of one-quarter and one-eighth circle segments constitute infringement, contributory infringement and/or inducing infringement of Claims 1-7 and 9-13 of the reissue patent. 35 U.S.C. § 271(c); *see* Findings of Fact ## 55 thru 61, *supra*. Defendants do not avoid infringement in this case by dividing a basic semi-cylindrical design anode into two or four parts and then connecting those parts in half-circle proportion. ***Amerace Esna Corp.*** **v.** ***Highway Safety Devices, Inc.***, ***supra,*** **330 F. Supp. at 319.**

E. Injunctive and Legal Relief; Attorney's Fees

27. Pursuant to 35 U.S.C. § 283, plaintiff is entitled to an injunction prohibiting defendants from further infringing the patent in suit, Re 27,529.

28. Defendants practiced fraud on plaintiff's patent by virtue of their unfair competition. Findings of Fact ## 51, 52, *supra*. The evidence introduced at trial conclusively demonstrates that defendants willfully and knowingly employed a strategic course of conduct to combat the initial successful impact realized by plaintiff's patent upon its introduction to the industry by diverting attention aroused by the patented anode designed to defendants' copies of that design.

Defendants expended substantial efforts in closely examining and copying the internal and external design of plaintiff's patented anode and in utilizing such drawings as resulted to produce the infringing devices. ASARCO used its market influence as a supplier of anodic metals (especially zinc) to encourage anode bracelet customers to purchase the infringing anode bracelets exclusively. It also attempted to prevent plaintiff, a relatively small company, from having sufficient anodic materials with which to produce the instant patented device. (Pltf.'s Exhibits 23-B thru 23-J, 28). ASARCO encouraged Broyles to assemble and produce infringing anode bracelets by agreeing to indemnify Broyles from liability resulting from any patent infringement litigation filed by plaintiff. Finding of Fact #63, *supra*.

29. The Court concludes upon a careful review of the testimony and demeanor of the witnesses, particularly the testimony with regard to the manner in which defendants manufactured and sold the infringing devices in question, that plaintiff is entitled to an accounting for damages for

past infringement sustained by it by virtue of defendants' infringement of the patent in suit.

30. The manner in which this litigation was conducted does not present the exceptional circumstances contemplated by the Congress under 35 U.S.C. § 285 so as to merit awarding reasonable attorney's fees to the prevailing party. Accordingly, plaintiff is not entitled to recover such fees pursuant to § 285.

31. Defendants filed a counterclaim in this action seeking a declaratory judgment that the patent in suit is invalid, that plaintiff unfairly competed with defendants in prosecuting this suit and that by attempting to enforce its patent, plaintiff has violated the antitrust laws of the United States. The counterclaim should be dismissed in its entirety: the patent in suit is valid and enforceable; plaintiff has therefore not competed unfairly in seeking to enforce the patent; and plaintiff has not violated the antitrust laws of the United States.

III. CONCLUSION

The patent in suit is valid and enforceable. Defendants are hereby enjoined from further infringing the patent. Plaintiff is entitled to an accounting for damages for past infringement of its patent and is not entitled to recover attorney's fees. Defendants' counterclaim is dismissed. In the event that any of the foregoing Findings of Fact also constitute Conclusions of Law, they are adopted as Conclusions of Law. In the event that any of the foregoing Conclusions of Law also constitute Findings of Fact, they are also adopted as Findings of Fact.

By agreement of the parties, trial of this case was bifurcated to permit initial adjudication by the Court of the issue of the validity and enforceability of the patent. Trial of that portion of the case pertaining to damages was deferred.

DONE at Houston, Texas, this 8th day of October, 1976.

CARL O. BUE, JR.
United States District Judge

APPENDIX B

United States Court of Appeals

Fifth Circuit.

May 7, 1979.

No. 76-4134.

CATHODIC PROTECTION SERVICE

v.

AM. SMELTING, ETC.

CATHODIC PROTECTION SERVICE
Plaintiff-Apellee,

v.

AMERICAN SMELTING & REFINING COMPANY,
FEDERATED METALS CORPORATION AND
WAYNE BROYLES ENGINEERING COMPANY
Defendants-Appellants.

Patentee filed an amended complaint alleging infringement of its resissue patent covering a galvanic anode adapted for the cathodic protection of relatively large-diameter pipelines submerged in water. Defendants filed a counterclaim wherein they sought a declaration, inter alia, that the reissue patent was invalid. The United States District Court for the Southern District of Texas, Carl O. Bue, Jr., J., ruled that the reissue patent was valid and infringed and entered judgment enjoining further infringement. Defendants appealed, and the Court of Appeals, Vance, Circuit Judge, held that: (1) the relevant prior art

included not only all prior art in the field of cathodic protection but also all prior art in analogous fields, and (2) the reissue patent was invalid by reason of nonobviousness.

Reversed and remanded.

1. Patents — 112.1, 312(1⅛)

Once a patent has been issued it is presumed valid and the burden of establishing invalidity rests with the party challenging the patent. 35 U.S.C.A. § 282.

2. Patents — 112.2

Presumption that a patent is valid is founded on the understanding that patent approval is a species of administrative determination supported by evidence. 35 U.S.C.A. § 282.

3. Patents — 112.3(4)

In an infringement suit wherein it is asserted as a defense that the patent is invalid because prior art was not submitted to the patent office, the foundation for the presumption of validity vanishes, the presumption itself is severely weakened and the court is required to scrutinize the patent more closely. 35 U.S.C.A. § 282.

4. Patents — 112.3(4)

Where, except for publication describing an unpatented anode commonly known in the cathodic protection field, no prior art was presented to patent office in connection with reissue application and reissue patent issued without examiner having been informed of additional prior art, court was required to consider the prior art against the patent without the presumption in favor of the patent's validity. 35 U.S.C.A. § 282.

5. Patents — 324.55(4)

Findings made by district court, in patent infringement action, with regard to factual inquiries that are necessary to determine obviousness must be reviewed under the clearly erroneous standard. Fed.Rules Civ.Proc. rule 52(a), 28 U.S.C.A.; 35 U.S.C.A. § 103.

6. Patents — 314(5)

The ultimate issue of nonobviousness is a question of law, not one of fact. 35 U.S.C.A. § 103.

7. Patents — 328(4)

Reissue patent No. 27,529 for galvanic anode adapted for the cathodic protection of relatively large-diameter pipelines submerged in water was invalid on the ground of nonobviousness. 35 U.S.C.A. § 103.

8. Patents — 51(1)

In connection with reissue patent for galvanic anode adapted for the cathodic protection of relatively large-diameter pipelines submerged in water, relevant prior art included not only all prior art in the field of cathodic protection but also all prior art in analogous fields. 35 U.S.C.A. §§ 101-103.

9. Patents — 18

Obviousness of patent for galvanic anode was established when features that distinguished the patented galvanic anode from closest prior art reference were disclosed in analogous structures in which the features performed an identical function. 35 U.S.C.A. § 103.

10. Patents — 16.5

When a claim is not anticipated by a prior art example, the level of ordinary skill in the pertinent art must be

resolved; this requires a preliminary determination as to what prior art is to be used by the hypothetical person skilled in the art.

11. Patents — 36.1(1), 36.2(1)

Where reissue patent for galvanic anode adapted for the cathodic protection of relatively large-diameter pipelines submerged in water was invalid because of nonobviousness, secondary considerations such as commercial success, long-felt but unsolved needs and the failure of others to invent such an anode did not lend patentability to the anode. 35 U.S.C.A. § 103.

Appeal from the United States District Court for the Southern District of Texas.

Before GEE and VANCE, Circuit Judges, and HUNTER, District Judge.*

VANCE, Circuit Judge:

I. CASE ORIENTATION

Cathodic Protection Service (Cathodic), filed this action on July 28, 1972, in the District Court for the Southern District of Texas alleging infringement of United States Letters Patent 3,616,422 (the original patent). The original patent, entitled "Galvanic Anode," was issued on October 26, 1971, on an application filed April 21, 1971. It covers a galvanic anode adapted for the cathodic protection of relatively large diameter pipelines submerged in water.

On September 26, 1973, Cathodic filed an amended complaint alleging infringement of United States Letters

* District Judge, of the Western District of Louisiana, sitting by designation.

Patent Re 27,529 (the reissue patent) which is the patent involved in this suit. The latter patent, which is a reissue of the original patent, was issued on December 19, 1972, on an application filed August 7, 1972. Both the reissue patent and the original patent were issued to Cathodic as assignee of Gordon L. Doremus and Jack G. Davis.

In this suit Cathodic accuses Waynes Broyles Engineering Company (Broyles) of infringement and American Smelting & Refining Company (ASARCO) of contributory infringement and of actively including infringement by Broyles. ASARCO,[1] a primary supplier of zinc, makes and sells zinc galvanic anodes. Broyles offers a complete cathodic protection service and distributes zinc galvanic anodes for ASARCO. Broyles and ASARCO counterclaimed seeking a declaration, (1) that the reissue patent is invalid, (2) that Cathodic competed unfairly with them by bringing this action, and (3) that Cathodic violated the antitrust laws by attempting to enforce the reissue patent.

Trial before the court commenced on January 16, 1975, and lasted until January 23. The court entered its original findings of fact and conclusions of law and judgment on February 12, 1976.[2] On February 23, 1976, ASARCO and Broyles moved for new trial or in the alternative for amended findings of fact and conclusions of law. They specifically requested that the finding of treble damages be reserved until after an accounting. A memorandum and order was entered on August 3, 1976, denying defendants' post-trial motion. The court agreed, however, to hold the treble damage question until the time of the accounting.

[1] Federated Metals Corporation is a division of ASARCO. Those companies will be collectively denominated ASARCO.

[2] In its original findings of fact and conclusions of law the court held the reissue patent valid and infringed, and entitled Cathodic to recover from ASARCO and Broyles treble damages for infringement.

On October 8, 1976, revised findings of fact and conclusions of law and a judgment were entered. The court ruled that the reissue patent was valid and infringed and entered judgment enjoining Broyles and ASARCO from further infringement. The counterclaim was dismissed in its entirety. ASARCO and Broyles appealed this ruling pursuant to 28 U.S.C. § 1292(a)(4).

II. FACTUAL ORIENTATION

The patent in issue covers a galvanic bracelet anode, which acts as a self-generating current battery when suitably mounted around underwater offshore pipelines. As described in its claim one, Cathodic's bracelet[3] consists of a pair of semi-cylindrical segments that are fitted around the pipe to form a full circle. Each segment has a cathodic core consisting of a pair of concentric steel bars that are entirely embedded within the anode body and adjacent to its inner periphery. The bars extend out the opposite longitudinal edges of the body where they are welded together to hold the bracelet on the pipe. Within the semi-cylindrical anodes, the cathodic cores are connected by angularly-spaced interlinking metal rods.[4]

Galvanic anodes are used to protect objects made of other metals, or cathodes, from corrosion. When the anode and the object to be protected are connected and submerged in a medium that conducts electricity, a small electric current begins to flow from one object to the other. This electric current impedes the corrosion process and can extend the useful life of pipelines forty years or longer. Such pipelines are usually covered with a protective coating to prevent corrosion. Anodes are fastened to them as a precaution against a failure of the coating; then the pipelines are usually coated with concrete to keep them submerged.

[3] Claim 1 of the United States Letters Patent Re 27,529 contains a description of the basic structure of Cathodic's anode.

[4] Claim 6 of Patent Re 27,529 omits the angularly-spaced interlinking metal rods, making their inclusion in this anode unnecessary. Claim 7 changes the continuous semi-cylindrical body wording of claim 1 to a continuous arcuate body, indicating that this anode need not be semicylindrical, but may be comprised of a pair of arcuate segments. Claim 13 changes the wording so that the body may be comprised of a plurality of arcuate segments rather than a pair.

Galvanic anodes of different shapes and sizes for land and marine use have been known for many years, and have been marketed by Cathodic, Broyles, and others since approximately 1958. Many prior patents on the cathodic protection art have been issued.[5] ASARCO has been a major supplier of zinc anode bodies for galvanic anodes since the anodes' conception.

Cathodic conceived its patented bracelet in 1968 and began manufacturing and marketing the bracelet early in 1969. Cathodic, Broyles and other people in the cathodic protection business, however, continued to market the old segmented designs.

Early in 1972 Broyles' customers began asking whether they could purchase anodes with a semicylindrical design. Broyles was aware of Cathodic's patent and conceived an alternate design, which, Broyles was satisfied, did not infringe Cathodic's patent. The customers accepted the alternate design, and Broyles began ordering zinc for the anode

[5] The district court made this finding of fact (Finding of Fact 5) and additionally found

> A typical, practical anode is comprised of a body of anodic metal (magnesium, zinc, or aluminum) containing a cathodic metal core which is largely embedded therein. The anodic metal is attached to the iron or steel body in such a way that a small electric current can pass between the anode and the body to be protected.

segments from ASARCO. ASARCO furnished Broyles anode segments, which Broyles assembled and sold to its customers.

When these anodes were being shipped, Cathodic had only the original United States patent No. 3,616,422, which had been issued on October 26, 1971. *All* of the claims of this original patent were limited in the scope of their coverage to anodes that included the following:

> (a) a *continuous semi-cylindrical* body of a galvanic anode metal, and
>
> (b) a core, which is cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery, in each segment is made up of
>
> (1) at least two axially-spaced metal bars having
>
> (2) *plurality of angularly-spaced metal rods* interlinking the bars.

The anode designed and sold by Broyles used a quarter-circle segment of galvanic anode material, instead of semi-cylindrical body, and its core did not include any angularly spaced metal rods.

Cathodic, however, learned of the Broyles transaction and promptly accused Broyles of infringing its patent. The concerned parties discussed the problem, but Cathodic continued to insist that the patent was infringed and eventually filed the original complaint in this suit.

Ten days after suit was filed, Cathodic filed an application to reissue the patent with claims that were much broader than the claims of the original patent[6] because

[6] Compare the alleged infringing anodes and the patented anode, Re 27,529, as described in Claims 7 and 13.

they covered anodes (1) whether or not semicylindrical and (2) without the angularly spaced metal rods interlinking the bars of the core.[7]

By this time ASARCO had examined the file wrapper[8] of Cathodic's original patent and discovered that Cathodic had failed to disclose to the Patent Office material prior art with which it was familiar. The prior art had also not been cited by the Patent Office. ASARCO promptly gave Cathodic notice not only of prior art, which was already known to Cathodic, but also of additional art, which had been found in searches made by ASARCO. This notice, which was made of record in this case pursuant to 35 U.S.C. § 282, was given for the purpose of allowing Cathodic the opportunity of disclosing the prior art to the Patent Office examiner while he was considering the reissue application.

Cathodic did not disclose any of the additional prior art to the examiner; thus the reissue patent issued without the examiner having been informed of the additional prior art.[9]

The claims in Reissue Patent 27,529 are crucial to the ultimate issue and therefore are set out in full:

What we claim and desire to secure by Letters Patent is:

[7] See Footnote 4.

[8] A file wrapper is the file containing all documents, communications and actions taken by the patentee and the Patent Office with regard to the patent application.

[9] The Section 282 Notice of Prior Art was filed with the district court on October 30, 1972. The prosecution of the reissue application on its merits was closed by the Patent Officer Examiner on September 20, 1972. Cathodic has seemingly urged this chronology of events as an excuse for its failure to submit this prior art to the patent office. *Veritatis simplex oratio est.* It was Cathodic's responsibility to submit prior art to the patent office not ASARCO's or Broyles', and the lateness of ASARCO's and Broyles' attempt to help is no excuse for Cathodic's irresponsibility.

1. A galvanic anode for cathodic protection of pipe lines, comprising:

(a) a pair of semicylindrical segments adapted to embrace a pipeline, each segment comprising:

(1) a continuous, semicylindrical body of a galvanic anode metal;

(2) A metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body;

(3) said core comprising:

(a) at least two axially-spaced, parallel metal bars;

(b) a plurality of angularly-spaced metal rods interlinking said bars; and

(c) each of said bars having end portions projecting from opposite, longitudinal edges of the anode body to form joint elements for connecting one of said segments to the other in pipe-embracing relation.

2. An anode according to claim 1 wherein said anode metal is a member selected from the group consisting of aluminum, zinc, magnesium, and alloys thereof.

3. An anode according to claim 1 wherein said core is constructed of mild steel.

4. An anode according to claim 1 including electric current conductor elements connected to said core for electrically connecting the core to the pipeline.

5. An anode according to claim 1 wherein one of said end portions is offset laterally to receive the

non-offset end portion of an opposed bar to form the joint therebetween.

6. A galvanic anode for cathodic protection of pipelines comprising:

(a) a pair of semi-cylindrical segments adapted to embrace a pipeline, each segment comprising:

(1) a continuous, semicylindrical body of a galvanic anode metal;

(2) A metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body:

(3) said core comprising:

(a) at least two axially-spaced, metal bars; and

(b) each of said bars having end portions projecting from opposite, longitudinal edges of the anode body to form joint elements for connecting one of said segments to the other in pipe-embracing relation.

7. A galvanic anode for cathodic protection of pipe lines, comprising:

(a) a pair of arcuate segments adapted to embrace a pipe line, each segment comprising:

(1) a continuous, arcuate body of a galvanic anode metal;

(2) A metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body;

(3) said core comprising:

(a) at least two axially-spaced metal bars;

(b) each of said bars having end portions projecting from opposite longitudinal edges of the anode body to form joint elements for connecting one of said segments to the other in pipe-embracing relation.

8. A galvanic anode according to claim 7, and

a plurality of angularly-spaced metal rods interlinking said bars.

9. An anode according to claim 7, wherein said anode metal is a member selected from the group consisting of aluminum, zinc, magnesium, and alloys thereof.

10. An anode according to claim 7, wherein said core is constructed of mild steel.

11. An anode according to claim 9, including electric current conductor elements connected to said core for electrically connecting the core to the pipeline.

12. An anode according to claim 11, wherein one of said end portions is offset laterally to receive the non-offset end portion of an opposed bar to form the joint therebetween.

13. A galvanic anode for cathodic protection of pipelines comprising:

a plurality of arcuate segments adopted to embrace a pipeline, each segment comprising:

(1) a continuous, arcuate body of a galvanic anode meal;

(2) a metal core cathodic to the anode metal concentrically and entirely embedded within the anode metal adjacent the inner periphery of said body;

(3) said core comprising:

(a) at least two, axially spaced-apart metal bars;

(b) each of said bars having end portions projecting from the opposed longitudinal edges of the said segments to form joint elements for connecting said segments to each other in pipe-embracing relation.

14. The anode according to claim 13, and at least one metal rod in each segment for interlinking said bars.

References Cited

The following references, cited by the Examiner, are of record in the patented file of this patent or the original patent.

UNITED STATES PATENTS

2,303,778 12/1942 Wesley .... 204—197 XR
2,656,314 10/1953 Osterheld ..... 204—197

OTHER REFERENCES

Cathodic Protection of Submarine Pipelines, 2 pp. pub. by Federated Meals Div. (1958).

FREDERICK, C. EDMUNDSON, Primary Examiner

ASARCO and Broyles contend that all fourteen claims are invalid because the subject matter defined by these claims is obvious under 35 U.S.C. § 103.

III. LEGAL ORIENTATION

[1-3] Once a patent has been issued it is presumed to be valid. The burden of establishing its invalidity rests with the party challenging the patent. 35 U.S.C. § 282.[10] This presumption is founded on the understanding that patent approval is a species of administrative determination supported by evidence. Consequently, in an infringement suit, when the defense of invalidity of the patent is raised on the ground that prior art was not submitted to the patent office, the foundation for the presumption vanishes, the presumption itself is severely weakened, and the court is required to scrutinize the patent more closely. *Zero Manufacturing Co.* v. *Mississippi Milk Producers Association,* 358 F.2d 853 (5th Cir.), *cert. denied,* 385 U.S. 841, 87 S.Ct. 93, 17 L.Ed.2d 74 (1966); *Cornell* v. *Adams Engineering Co.,* 258 F.2d 874 (5th Cir. 1958).

[4] Cathodic presented no prior art to the patent office except Bulletin 191. Bulletin 191 is a publication circulated by ASARCO that describes an unpatented anode commonly known in the cathodic protection field. We, therefore, must consider the prior art against Cathodic's patent without the presumption in favor of its validity.

The conditions of patentability are set forth in the Patent Act in three sections, 35 U.S.C. §§ 101, 102 and 103. Sections 101 and 102 express the newness and usefulness tests.[11] Section 103 expresses the nonobviousness test with which we are most concerned:

[10] § 282. Presumption of validity; defenses

A patent shall be presumed valid. Each claim of a patent (whether in independent or dependent form) shall be presumed valid independently of the validity of other claims; dependent claims shall be presumed valid even though dependent upon an invalid claim. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting it.

[11] Title 35 USC § 101. Inventions patentable

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would

Title 35 U.S.C. § 102. Conditions for patentability; novelty and loss of right to patent

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or

(c) he has abandoned the invention, or

(d) the invention was first patented or caused to be patented, or was the subject of an inventor's certificate, by the applicant or his legal representatives or assigns in a foreign country prior to the date of the application for patent in this country on an application for patent or inventor's certificate filed more than twelve months before the filing of the application in the United States, or

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent, or

(f) he did not himself invent the subject matter sought to be patented, or

(g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

> have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Six Supreme Court opinions, which have dealt with the subject of invention in the last three decades, guide our determination. They extend from *Great Atlantic & Pacific Tea Co.* v. *Supermarket Equipment Corp.*, 340 U.S. 147, 71 S.Ct. 127, 95 L.Ed. 162 (1950), to *Sakraida* v. *Ag Pro, Inc.*, 425 U.S. 273, 96 S.Ct. 1532, 47 L.Ed.2d 784 (1976). The first opinion after *A & P*, and the first to specifically treat the nonobviousness language in Section 103, was *Graham* v. *John Deere Co.*, 383 U.S. 1, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966). It was accompanied by *United States* v. *Adams*, 383 U.S. 39, 86 S.Ct. 708, 15 L.Ed.2d 572 (1966). This duo was followed by *Anderson's-Black Rock, Inc.* v. *Pavement Salvage Co.*, 396 U.S. 57, 90 S.Ct. 305, 24 L.Ed.2d 258 (1969), *Dann* v. *Johnston*, 425 U.S. 219, 96 S.Ct. 1393, 47 L.Ed.2d 692 (1976), and *Ag Pro* in 1976. These cases have fleshed out the requirements that nonobviousness imposes on a determination of patentability. The difficulty of applying the requirements to specific fact situations, however, can be equated to the difficulty of invention. In this atmosphere we are mindful of the language of Mr. Justice Frankfurter, dissenting in *Shapiro* v. *United States*, 335 U.S. 1, 56, 68 S.Ct. 1375, 1403, 92 L.Ed. 1787 (1948), "It is the part of wisdom, particularly for judges, not to be victimized by words."

The Supreme Court first outlined in *Graham* v. *John Deere Co., supra*, 383 U.S. at 17-18, 86 S.Ct. at 694, the nature of the inquiry required under § 103:

> While the ultimate question of patent validity is one of law, *Great A & P Tea Co.* v. *Supermarket Equipment Corp., supra*, 340 U.S. at 155, 71 S.Ct. at 131, the § 103 condition, which is but one of three conditions, each of which must be satisfied, lends itself to several basic factual inquiries. Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy.

In *Lear, Inc.* v. *Adkins*, 395 U.S. 653, 89 S.Ct. 1902, 23 L.Ed.2d 610 (1969), the court referred to the test in *Graham* as a "demanding standard of invention." *Id.* at 676, 89 S.Ct. 1902. In *Anderson's-Black Rock* the court reiterated the test enunciated in *Graham* and emphasized that "'strict observance' of those requirements is necessary." *Anderson's-Black Rock* v. *Pavement Salvage Co., supra*, 396 U.S. at 62, 90 S.Ct. at 308.

[5, 6] The district court's findings with regard to the "factual inquiries" demanded by *Graham* must be reviewed under the clearly erroneous standard of Federal Rule of Civil Procedure 52(a).[12] The ultimate issue of obviousness

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[12] *See Stamicarbon, N.V.* v. *Escambia Chemical Corp.*, 430 F.2d 920 (5th Cir.), *cert. denied*, 400 U.S. 944, 91 S.Ct. 245, 27 L.Ed.2d 248 (1970). *See also Metal Arts Co.* v. *Fuller Co.*, 389 F.2d 319 (5th Cir. 1968).

is, however, a question of law,[13] not of fact. *See, e. g., Graham* v. *John Deere Co., supra.*

[7] Our comparison of the present case with the reported authorities and our examination of the voluminous record before us convinces us that the district court's first and third factual findings under *Graham* were clearly erroneous and that the court erred in its conclusion that the reissue patent was valid. Cathodic's reissue patent does not satisfy the test of nonobviousness. Our conclusion that Patent Re 27,529 is invalid on this ground completely disposes of the appeal and obviates our consideration of the other issues. *See Waldon, Inc.* v. *Alexander Manufacturing Co.*, 423 F.2d 91 (5th Cir. 1970); *Zero Manufacturing Co.* v. *Mississippi Milk Producers Association, supra.*

IV. SCOPE AND CONTENT OF PRIOR ART

The three factors emphasized in *Graham* must guide our examination of the district court's findings of fact and conclusions of law. Although the district court did not verbalize a specific finding as to the scope of the prior art, we find the court's comments on the relevance of the prior art submitted by ASARCO to be equivalent to such a determination:

> A review of the prior art cited by defendants to plaintiff, pursuant to 35 U.S.C. § 282, or to this Court, reveals the lack of relevance or materiality of such art, and demonstrates that because of the nature of the invention and the usage requirements in the industry, only the Bulletin 191 anode is pertinent. Plaintiff's refusal to cite as pertinent other prior art than Bulletin 191 to the Patent Examiner in submitting the applications for the original and reissue patents is therefore of no consequence.[14]

[13] *Kiva Corp.* v. *Baker Oil Tools, Inc.*, 412 F.2d 546 (5th Cir.), *cert. denied*, 396 U.S. 297, 90 S.Ct. 262, 24 L.Ed.2d 226 (1969); *Swofford* v. *B & W, Inc.*, 395 F.2d 362 (5th Cir.), *cert. denied*, 393 U.S. 935, 89 S.Ct. 296, 21 L.Ed.2d 272 (1968).

[8] The district court's conclusion that only the Bulletin 191 anode was relevant prior art[15] was a fundamental error. The prior art that must be considered includes not only all prior art in the field of cathodic protection, but also all prior art in analogous fields. *See Mandel Bros.* v. *Wallace*, 335 U.S. 291, 69 S.Ct. 73, 93 L.Ed. 12 (1948); *Gerner* v. *Moog Industries, Inc.*, 383 F.2d 56 (8th Cir. 1967), *cert. denied*, 390 U.S. 922, 88 S.Ct. 855, 19 L.Ed.2d 981 (1968).[16]

[14] Finding of Fact 34.

[15] Conclusion of Law 14.

[16] The Supreme Court indicates that it gives wide latitude to its finding on the scope of the prior art in its discussion of systems using flowing water to clean animal wastes from barn floors.

> Among the labors of Hercules is the following:
>
> "Heracles now set out to perform his fifth Labour, and this time his task was to cleanse the stables of Augeas in a single day. Augeas was a rich king of Elis, who had three thousand cattle. At night the cattle always stood in a great court surrounded with walls, close to the king's palace, and as it was quite ten years since the servants had cleaned it out, there was enough refuse in the court to build up a high mountain. Heracles went to Augeas and asked if he would give him the tenth part of his flocks if he thoroughly cleansed his stables in a single day. The king looked upon this as such an absolutely impossible feat that he would not have minded promising his kingdom as a reward for it, so he laughed and said, 'Set to work, we shall not quarrel about the wages,' and he further promised distinctly to give Heracles what he asked, and this he did in the presence of Phyleus, his eldest son, who happened to be there. The next morning Heracles set to work, but even his strong arms would have failed to accomplish the task if they had not been aided by his mother-wit. He compelled a mighty torrent to work for him, but you would hardly guess how he did it. First he opened great gates on two opposite sides of the court, and then he went to the stream, and when he had blocked up its regular course with great stones, he conducted it to the

We are of the same general opinion as is the eighth circuit:

> "prior art" may include not only earlier devices and publications but also similar devices whether or not in related areas to the patented device and with respect to a simple mechanical device utilizing universally known principles permits referring to the field of mechanics itself.

Skee-Trainer, Inc. v. *Garelick Manufacturing Co.*, 361 F.2d 895, 898 (8th Cir. 1966).

The prior art submitted by ASARCO and Broyles is extremely relevant. Not only is the art from the field of galvanic anodes, but it also discloses the same functional or mechanical features that Cathodic claims in its patent. Mr. Doremus, the original patent holder; his attorney, Mr. Werlin; Mr. Cockfield, the searcher; and the Patent Office examiner believed the relevant field of art to be broader than did the district court.

Mr. Doremus, a noted expert in the field, testified about the type of information that should be considered in designing a cathodic protection system and the places one would look to find this information. In his testimony, he conceded that the scope of relevant art studied in designing a galvanic anode for cathodic protection of underwater pipelines would not be limited to Bulletin 191:

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court that required to be cleansed, so that the water streamed in at one end and streamed out at the other, carrying away all the dirt with it. Before evening the stream had done its work and was restored to its usual course." C. Witt, Classic Mythology 119-120 (1883).

Sakraida v. *Pro, Inc., supra*, 425 U.S. at 275 n. 1, 96 S.Ct. at 1534 n. 1. *See also Fred Whitaker Co.* v. *E. T. Barwick Indus., Inc.*, 551 F.2d 622 (5th Cir. 1977).

Q During this twenty-odd years, twenty-five years or so that the company has been in business, they have designed galvanic anodes for a number of different kinds of structures, haven't they?

A Yes, indeed.

Q And that's underwater structures, as well as underground structures, is that correct?

A Yes.

Q And how about equipment which is used in the refineries and chemical plants, and that sort of thing? Have you designed galvanic anode systems for those?

A Yes.

Q And due to your work with this equipment it's necessary to make some sort of study of the equipment and become familiar with it, isn't it?

A That's true.

Q So over the many years that you have been in this business, well, you must have gained considerable familiarity with a large number of different kinds of equipment, isn't that correct?

A Yes, sir.

Q And this is the sort of thing that any cathodic protection engineer necessarily becomes familiar with in the course of his everyday business, isn't it?

A If he's good.

Q Now, when you design such systems, do you try to draw upon all of this background of experience that you have in order to be able to design the best possible system in each application?

A Well, your mind screens out a large area, depending on the project you are working on. So your mind limits you to certain anodes or systems or components that are pertinent to the project you have in mind, be it a water tank, or a pipeline. You wouldn't consider everything in the field every time you approach a given design problem.

Q All right, well, let's go to something with the same environment, then. Suppose we are talking about an offshore platform. Do you ignore what knowledge you have of anodes for offshore platforms in designing anodes for pipelines?

A Well, not completely, of course, because you are quite close together. You are in a marine environment in both cases.

Q And how about pilings, isn't that information which you would take into account?

A Anodes for pilings?

Q Yes.

A Yes, sir.

Q And equipment which handles sea water, is that information which you would take into account?

A Yes.

Q And anytime you have any kind of structure which is of similar shape and your problem is one of geography or configuration, don't you necessarily take into account the experience and knowledge that you have concerning other structures of similar configuration and geography?

A Yes. This is my point, you take into account something that is applicable and you subconsciously screen out things that are not applicable.

Mr. Werlin described the areas in which a patent examiner would be expected to look in determining the disclosures and, hence the relevance of prior art. Mr. Werlin specifically testified to the places in which he presumed Mr. Cockfield, the searcher employed by Werlin, had searched for relevant prior art. Mr. Werlin also conceded that many patents discarded by the district court were relevant:

Q But he [patent office examiner] wouldn't just look under the class under which bracelet anodes for underwater pipelines may be classified in order to determine whether a bracelet anode for an underwater pipeline is a patentable structure, would he?

A No, I don't think so.

Q He might look in sub-classes where other things for underwater pipelines are classified, might he not?

A He might.

Q He might look in sub-classes where other kinds of anodes are classified, might he not?

A Yes.

Q As a matter of fact, Mr. Cockfield did that, didn't he, when he made the search for you?

A I'm sure he must have.

* * * *

Q He would know to search in the places where relevant art might be found, wouldn't he?

A I would suspect so.

Q I hand you a copy of Defendants' Exhibit 32, which is a book of patents, and the four patents in there with the orange tabs are, I believe, patents which were sent to you by Mr. Cockfield, is that right, Patent Nos. 1,664,800, 2,882,213, 3,001,924, and 3,240,512.

Q Did you look at these patents when they were first sent to you?

A I'm sure I must have.

* * * *

Q Now, semi-cylindrical zinc anodes are relevant to the subject matter that is to be patented, isn't that right?

A Yes.

* * * *

Q It [Douglas Patent] would be, then — you would agree that that's relevant to the subject matter, to the patentability of the subject matter of your patent, is that right?

A Yes, I would assume any — almost any anode would be.

* * * *

Q And your answers with respect to the Battis patent, if I were to ask the same series of questions that I did about the Douglas patent, would be essentially the same, isn't that correct?

A Yes.

* * * *

Q Now, look at the next two patents in the book there, with the white tabs on them, the patents for Wesley, No. 2,303,778, and 2,656,314, Osterheld, O-s-t-e-r-h-e-l-d. Do you recognize those as the patents that the patent office cited in the first office action on your application?

A . . . .

Yes, those were cited by the patent office.

* * * *

Q And what did he say that they were cited to show?

A "Claim 6 is rejected under the 35 U.S.C. 103 as unpatentable over Bulletin 191 alone, or in view of Wesley or Osterheld.["] And Claim 6 is limited to where the end portions are offset laterally, the offset portions on one of the anodes is offset to receive the non-offset end portion of an opposed bar. It's simply on the form of the connection between the pieces that stick out of the anodes. And that's what he cited it against.

As is evident from Mr. Werlin's testimony, his searcher, Mr. Cockfield, determined that more prior art was relevant than the Bulletin 191.

In addition to Bulletin 191, the patent office examiner at least considered the Wesley and Osterheld patents to be relevant. In fact the examiner found these patents to be so relevant that initially he rejected one of the original claims and eight of the reissue claims based on these patents.

Claim 6 is rejected under 35 U.S.C. 103 as unpatentable over Bulletin 191 alone or in view of Wesley or Osterheld. "One" of said end portions is off-set laterally" is not considered to differentiate from the teaching of Bulletin 191. However, even if it did, it is obvious from the secondary references that broadly shaping end portions to fit a butting portions is practiced on the art.

* * * *

Claims 7-14 are rejected under 35 U.S.C. 103 as unpatentable over R.[17]

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[17] R is the designation given to the prior art references considered by the patent office examiner. The prior art references considered by the patent office examiner were the Bulletin 191, Wesley and Osterheld Patents. In the file wrapper for Reissue Patent RE 27,529, at page 23, we find a reference in Part III, entitled Notification of Rejection(s) and/or Objections(s) (35 U.S.C. § 132), to R:

The district court recognized that the Wesley Patent and Osterheld Patent had been cited by Cathodic to the patent examiner;[18] however, it erroneously excluded these patents and the other patents cited by ASARCO and Broyles from the scope of the prior art to be considered. This fundamental error tainted the remaining findings of fact and ultimately foreclosed the correct conclusion of law.

V. DIFFERENCES BETWEEN CLAIMS AT ISSUE AND PRIOR ART

[9] We hold that obviousness is established when features that distinguish the patented anode from the closest prior art reference are disclosed in analogous structures in which these features perform an identical function. *See Mannix Co.* v. *Healey,* 341 F.2d 1009 (5th Cir. 1965). This position is also expressed by the Patent Office in its Manual of Patent Examining Procedure:

> 706.02 *Rejection on Prior Art*
>
> [Reprint of 35 U.S.C. § 102 and 35 U.S.C. § 103]
>
> By far the most frequent ground of rejection is on the ground of unpatentability in view of the prior art,

R discloses segmented anodes surrounding the pipe to be protected.

R discloses the exact reasons that Claims 7-14 were initially rejected by the patent examiner. See footnote 4.

[18] The district court made the following findings of fact:

> 37. . . .
>
> The patent to Wesley does disclose a means of combatting underground corrosion electrochemically, and plaintiff did cite this prior art to the Patent Examiner in its application for the reissue patent. . . .
>
> • • • • •
>
> 39. . . .
>
> The patent to Osterheld does disclose a connection from the anodic to the cathodic metal, and plaintiff did cite this prior art to the Patent Examiner in its application for the reissue patent. . . .

> that is, that the claimed matter is either not novel under 35 U.S.C. 102, or else it is obvious under 35 U.S.C. 103. The language to be used in rejecting claims should be unequivocal. See § 707.07(d).
>
> • • • •
>
> 35 U.S.C. 103 (Obviousness)
>
> In contrast, 35 U.S.C. 103 authorizes a rejection where to meet the claim, it is necessary to modify a single reference or to combine it with one or more others.

Once the art in which the ordinarily skilled person must be said to have knowledge is widened to include most of the other cathodic protection anodes, it is manifest that the patent claims here are obvious. They simply do not describe a cathodic anode that performs functions different from those performed by the prior art. Although Cathodic's anode may achieve those functions in a slightly more efficient manner, the functions themselves were well established in the wider cathodic protection field. The improved performance that resulted from reduction in the number of anode segments and elimination of external bands was hardly unanticipated. It was readily predictable when those changes, performing the same function that they were performing in other prior art, were applied to the Bulletin 191 anode.

Although the district court erroneously limited its scope, it did make findings of fact with regard to that prior art. Viewing these findings in the light of a correct determination of the relevance of prior art we find that Cathodic may have an improved product, but not an innovatively different one.[19] All of the differences that the district

[19] In *Graham, supra,* the Supreme Court opined that the fifth circuit was incorrect in holding the patent valid on the basis that the combination produced an old result in a cheaper and otherwise more advantageous way. In short, result-oriented reasoning was not to be enough. The Court insisted, "The emphasis on non-obviousness is one of inquiry, not quality . . ." *Graham* v. *John Deere Co., supra,* 383 U.S. at 17, 86 S.Ct. at 693-694.

court found between the Bulletin 191 anode and Cathodic's patented anode are shown to be functioning in the exact manner in the prior art as they function in Cathodic's patented anode.

> "[U]nless more ingenuity and skill . . . were required . . . than were possessed by an ordinary mechanic acquainted with the business, there [is] an absence of that degree of skill and ingenuity which constitutes essential elements of every invention. In other words, the improvement is the work of the skillful mechanic, not that of the inventor." *Hotchkiss* v. *Greenwood,* 52 U.S. (11 How.) 248, 267, 13 L.Ed. 683, 691 (1851), *quoted with approval in Sakraida* v. *Ag Pro, Inc.,* 424 U.S. at 279, 96 S.Ct. at 1537.

Robbins Co. v. *Dresser Industries, Inc.,* 554 F.2d 1289, 1294 (5th Cir. 1977). Similarly, the record before us discloses innovations that are the work of a skilled mechanic rather than an inventor.

The district court's findings of fact concerning the disclosures of the prior art, however, are not clearly erroneous and are therefore controlling. Fed.R. Civ.P. 52(a). The pertinent parts of these findings,[20] set out in full in Appendix 1 to this opinion, demonstrate that each element of Cathodic's patented anode, which the district court found to be absent in the Bulletin 191, is clearly disclosed in the prior art.

Both Mr. Doremus and Mr. Werlin specifically testified that some of the prior art showed structural features cited by the district court in finding that Cathodic's anode "differed from the Bulletin 191 anode by having cores concentric to the pipeline, by having no external bands to secure the anode to the pipe and by reducing the number of segments per bracelet."[21] Pertinent parts of the testimony of Mr. Doremus, Mr. Werlin, and Dr. Pennington, ASARCO's and Broyles' expert, are set out in Appendix 2. The testimony adds to the findings of the district court and substantiates our conclusion that all of the elements of Cathodic's bracelet anode were very old, and were disclosed to be functioning in the prior art in the same manner as in Cathodic's anode.

[20] Findings of Fact 35-45.

It was readily apparent to those skilled in the art that one way of securing an anode to the subject to be protected is by using extending internal cores thus eliminating the necessity of external bands. The semicylindrical design was within the skill of the art as were the entirely embedded cores with interlinking steel rods. *Facile est inventis addere.*

VI LEVEL OF ORDINARY SKILL IN THE ART

[10] When a claim is not anticipated by a prior art example, the level of ordinary skill in the pertinent art must be resolved. Although it did not deal in detail with the level of ordinary skill in the pertinent art, the district court held,

> In the insular world of cathodic protection of large offshore pipelines, plaintiff's novel invention is not anticipated by any prior art, and nothing in any prior art patent or combination of patents enables a person skilled in the art to construct plaintiff's invention. Without utilizing the teachings of plaintiff's patent, such a person could not rely solely upon the teaching of prior art patents to combine or modify such patents in the manner disclosed in the instant suit. Indeed, utilizing such prior art, especially the most pertinent prior art, the Bulletin 191 anode, persons in the indus-

[21] Finding of Fact 10.

> try looked toward use of stronger external bands as the next trend in development.[22]
>
> * * * *
>
> . . . Against the background of the scope and content of the prior art and the level of ordinary skill in the art, the claimed subject matter of the patent in suit was not obvious to a man of ordinary skill in the art at the time the invention was made and was not anticipated by prior art, whether the prior art asserted is taken singly, or in combination.[23]

To the extent that this holding constitutes a finding of fact with regard to the level of ordinary skill in the art, it is clearly erroneous.

The level of ordinary skill step requires a preliminary determination: what prior art is to be used by the hypothetical person skilled in the art? This preliminary determination's significance was illustrated in the *Calmar* v. *Cook Chemical* and *Colgate-Palmolive* v. *Cook Chemical* section of the *Graham* v. *John Deere Co. opinion.* In *Graham* the patentee of a pump sprayer invention argued that a particular patent was not in the pertinent prior art because it related to containers having pouring spouts rather than pump sprayers. The court disposed of that argument — and the Cook patent — by responding that "[t]he problems confronting [the patentee] and the insecticide industry were not insecticide problems; they were mechanical closure problems. Closure devices in such a closely related art as pouring spouts for liquid containers are at the very least pertinent references. See, II Walker on Patents § 260 (Deller ed. 1937)." *Graham* v. *John Deere Co., supra,* 383 U.S. at 35, 86 S.Ct. at 703.

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[22] Finding of Fact 33.

[23] Conclusion of Law 48.

The hypothetical person is a mechanically skilled individual familiar with the design of devices in the industry. *See Robbins Co.* v. *Dresser Industries, Inc., supra; Systematic Tool & Machine Co.* v. *Walter Kidde & Co.,* 555 F.2d 342 (3rd Cir.), *cert. denied,* 434 U.S. 857, 98 S.Ct. 178, 54 L.Ed.2d 128 1977). By eliminating the pertinent prior art the district court unduly restricted its view of the ordinary skill in the art. Had the district court correctly made the initial determination, it would have charged the person of ordinary skill with the knowledge disclosed in this pertinent prior art. Only then would the court have been in a position to decide whether application of the references and uses from the pertinent prior art to achieve the reissue patent's result would have been obvious to the hypothetical person.

As has been shown in the previous sections, persons skilled in the art were able to fully embed anode cores, to make cores concentric, to fasten anodes and other bodies to pipes without external bands, to use a minimum number of arcuate segments, and to use interlocking rods between core bars and anodes. Mr. Doremus was not of the opinion that it would take unusual skill to change the prior art into the patented device.[24] He explained that it would be logical to remove the two circumferential bars of the Bulletin 191 anode into the body of the anode and embed them within the anode material, and that the use of the interlinking rods was a "logical extension" of the core rods of the Bulletin 191 anode. When Mr. Andrews was asked to make an

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[24] The following testimony given by Mr. Doremus reflects this impression:

> A . . . . We adapted a flat anode with a longitudinal core, to make bracelets. . .
>
> Q So there is one instance where you did look to your previous knowledge of anodes which are useful for other purposes and adapt them to a different application, is that right?
>
> A Yes.

anode fit upon a circular body, he simply bent a flat anode into an arc. Cathodic's own bulletin[25] points out that the various anodes they sell may be used in many ways, including cathodic protection of ship hulls, offshore structures and pipelines, thus showing the interchangeability of the technology and the level of skill in the art.

VII. SECONDARY CONSIDERATIONS

[11] Finally, Cathodic urges that secondary considerations like commercial success, long felt but unsolved needs, and the failure of others to invent such an anode should be utilized as indicia of nonobviousness. The district court found that these considerations reinforced its determination of nonobviousness.[26]

Despite Cathodic's contention and the district court's finding, the secondary considerations do not lend patentability to this anode. Although the district court's true error was its determination of nonobviousness and not its use of such secondary considerations,[27] the following words of Mr. Justice Brennan are pertinent:

> Though doubtless a matter of great convenience, producing a desired result in a cheaper and faster way, and enjoying commercial success, [the invention] "did not product a 'new or different function' . . . within the test of validity of combination patents." *Anderson's-Black Rock* v. *Pavement Co., supra,* 396 U.S., at 60, 90 S.Ct., at 308, 24 L.Ed.2d, at 261. *These desirable benefits "without invention will not make patentability." Great A & P Tea Co.* v. *Supermarket Corp.,* 340 U.S., at 153, 71 S.Ct., at 130, 95 L.Ed., at 167.

Sakraida v. *Ag Pro., Inc., supra,* 425 U.S. at 282-283, 96 S.Ct. at 1537-38 (emphasis added). Because we hold that the claims made here are clearly obvious, we need not examine the secondary considerations. *See Roanwell Corp.* v. *Plantronics, Inc.,* 429 U.S. 1079, 97 S.Ct. 826, 50 L.Ed.2d 800 (1977) (White, J. joined by Brennan, J., dissenting from denial of certiorari)[28] (quoting *Goodyear Tire & Rubber Co.* v. *Ray-O-Vac Co.,* 321 U.S. 275, 279, 64 S.Ct. 593, 88 L.Ed. 721 (1944)).

VIII. CONCLUSION

Cathodic's reissue patent is invalid. The district court's contrary holding and its finding of infringement by appellants necessitates our reversal of its judgment for further proceedings in conformity with this opinion.

REVERSED AND REMANDED.

APPENDIX 1

35. The patent to Mills, No. 1,664,800, issued April 3, 1928, discloses *semi-cylindrical anodes for a pipeline* to be buried below ground. . . .

[25] Cathodic distributed a bulletin entitled, "*AZCO Zinc Anodes.*" The bulletin describes a variety of different anode configurations some of which disclose entirely embedded cores with ends protruding from either end of the anode material. The bulletin also sets out the uses for which the described anodes are designed.

[26] Finding of Fact 49.

[27] The district court's findings of fact and conclusions of law indicate that the court used these secondary considerations only to bolster its conclusion of nonobviousness.

[28] In *Roanwell,* the Supreme Court considered certiorari in a second circuit case, *Plantronics, Inc.* v. *Roanwell Corp.,* 403 F.Supp. 138 (S.D. N.Y. 1975), *aff'd,* 535 F.2d 1397 (2nd Cir. 1976) (per curiam). The panel decision in that case is not inconsistent with the above analysis. The court said, "In view of the ample evidence of obviousness, plaintiff's arguments concerning secondary factors are not persuasive." 535 F.2d at 1398. It was the district court opinion, which relied on secondary considerations, with which Justices White and Brennan took issue in their dissent from denial of certiorari.

The patent to Mills *does disclose use of arcuate anode* segments for installation onto the pipe. However, the patent is not designed for use in submerged pipelines, does not require use of core to promote even distribution of current on the pipeline and even consumption of the anodic metal, is vague in its description of the core and does not disclose any particular means by which to secure the anode to the pipeline.

* * * *

36. The patent to Godfrey, No. 2,067,839, issued January 12, 1937, discloses a cylindrical boat propeller shaft anode....

The patent to Godfrey does disclose an anode comprised of *two semi-circular sections*.... Further, the Godfrey patent provides for the use of *non-metallic cores which are not completely embedded in the anode*.... Finally, the type of mechanical connections required by the Godfrey patent would be inappropriate in a pipeline application.

* * * *

37. The patent to Wesley, No. 2,303,778, issued December 1, 1942, discloses a soil pipe of composite ferrous layers designed to prevent corrosion....

The patent to Wesley does disclose a means of combatting underground corrosion electrochemically.... However, the patent does not disclose a bracelet but rather an envelopment of whole sections of pipe with layers of anodic materials.

* * * *

38. The patent to Harris, No. 2,619,455, issued November 25, 1952, discloses a galvanic anode with a *wire core, being separated into segments held together by the core,* for use in protecting iron tanks.... *The seminal feature of the patent is its rod-like anode with a flexible* metallic core embedded lengthwise in the body of the anode.

The patent to Harris does disclose a *co-axial wire core completely embedded in the anodic material.* However, the anode has longitudinally spaced-apart notches to be broken into segments to permit formation of a polygon and is not designed to combat the problems of scale and durability which bracelet anodes must overcome. The segments are not arcuate, and the patent does not disclose any rods which cross-link core bars.

* * * *

39. The patent to Osterheld, No. 2,656,314, issued October 20, 1953, discloses a means of combatting corrosion in hot water storage tanks....

The patent to Osterheld *does disclose a connection from the anodic to the cathodic metal*.... However, credible evidence at trial demonstrated that the Osterheld patent bears only small relationship to the reissue patent, especially with regard to the scale of the former anode and its lack of reference to a bracelet application.

* * * *

40. The patent to Sabins, No. 2,826,543, issued January 31, 1955, discloses a sacrificial magnesium anode with insulation to prevent premature disintegration of the anode by localized galvanic action. The patent features *laterally spaced, longitudinally extending core rods connected by cross-linking rods in the core structure,* making use of magnesium as the preferred anodic material.

The patent does disclose an anode with *internal core that is intended for marine use.* However, such use would be limited to so-called hull structures, because of the absence of arcuate design. The patent is not relevant to a bracelet anode application for a pipeline.

* * * *

41. The patent to Douglas, No. 2,882,213, issued on April 14, 1959, discloses a galvanic anode designed for marine use. . . .

The patent does disclose an anode with *embedded core material and longitudinal edges with ends projecting from either side.* However, the patent is rectangularly shaped with no arcuate design and is intended to be used principally as a hull anode. Moreover, the patent utilizes a laminated covering around the anode for insulation purposes which differs from the type of coating required for the reissue patent. No concentric core structure is shown.

* * * *

42. The patent to Battis, No. 3,001,924, issued September 26, 1961, discloses a galvanic anode comprised of magnesium to which an electrical conductor is connected. . . . *The patent discloses a plug of metal, cathodic to magnesium (such as zinc or aluminum) but anodic to the ferrous metal conductor which protrudes from either end of the anode.*

The Battis patent does disclose an embedded conductor with external straps extending from the sides of the anode. However, the anode is rectangular, lacks an arcuate design and is useful primarily as a ship hull anode. The patent also does not disclose usage of internalized core rods pertinent to the instant application and requires usage of two sets of anodic material within the core.

* * * *

43. The patent to Fairchild, No. 3,197,262, issued on July 27, 1965, discloses a pipe protector adapted for use with drill pipe section. . . .

The patent discloses placement of a bracelet around a drill pipe but has no relation to cathodic protection and does not contemplate potential problems of design and

placement of bracelet anodes on offshore pipelines. Further, the pertinent core design is not discussed.

* * * *

44. The patent to Pennington, No. 3,240,512, issued on March 15, 1966, discloses a conduit construction and weight means for underwater pipelines. . . .

The patent does disclose a sleeve for underwater pipelines *having two or more arcuate segments, each segment comprising a continuous arcuate body of concrete, with a metal core concentrically embedded entirely within the concrete adjacent to the inner periphery of the body.* However, the specific core design is not disclosed in the patent, nor are straps or other materials used to facilitate a welded or brazed connection to the pipe. Further, the metal base fits snugly on and directly against the pipe, contrary to the teaching of the reissue.

* * * *

45. The military specification (MIL-A18001-H) cited by defendants (Defts.' Exhibit 12) discloses ship hull anodes *with straps extending from either end of the anodic body.* The design does not disclose completely embeded concentric cores and bears the same difficulty of adjustment to bracelet pipeline use as do the previously referenced patented hull anodes.

* * * *

. . . . *The LL-26 anode's core consisted of a bar of steel with end portions projecting from the opposite longitudinal ends of the anode body.* These end portions were welded to the external conical wall surface of the fairwater cone. . . .

The LL-26 anode does disclose concentrically extending cores embedded within the anodic body. . . .

The LL-26 anode is a flat anode *which was bent to fit onto a cone.* . . .

[Emphasis supplied.]

APPENDIX 2

Generally, Mr. Doremus testified that it was "as logical as anything you could come up with," to place the external straps of the Bulletin 191 anode inside the core and leave the internal core structure of the Bulletin 191 anode the same.

Q . . . . "The same thing applies to the rods 16, which cross link between the strap cores, 14. They are sort of a logical extension of the fact that you had longitudinal rod cores in the Bulletin 191 anode with an external circumferential band so that when we moved the bands internally, embedded them in the bracelet, the thought was naturally to leave what was originally a core in the segment, leave it where it was." That's what you testified to?

A Yes, it is. And it's as logical as anything you could come up with.

As Mr. Doremus testified, however, this was not the use of inventive faculties, but was in fact very old in the art.

Q Now, embedded cores were, of course, very, very old, were they not?

A Oh, yes.

* * * *

Q And this [entirely embedding the core and making it adjacent to the inner periphery] has been common practice for many, many years, also, has it not?

A Yes.

With respect to the Godfrey patent, Mr. Doremus testified as follows:

Q And the Godfrey patent shows two semi-cylindrical segments, isn't that right?

A It does.

Q And if you could get a pipeline that is one inch in diameter, it would be adaptable to embrace such a pipeline, wouldn't it?

A It could. It wouldn't be a good bracelet anode for a pipeline, but if you wanted to put it around your pipeline, Mr. Conley, you could.

Q And the segments consist of a continuous acruate body of a galvanic anode metal, isn't that right?

A That's correct.

Q And it has a metal core cathodic to the anode metal concentrically embedded within the anode metal adjacent to the inner periphery, is that right?

* * * *

A It does disclose a metal core.

* * * *

Q Those ends of the core are used to connect it together, aren't they? Connect the two halves?

A Yes, they are.

Q And they are also used as the conductor for electrical current between the anodic material and the shaft, in this case, or pipe, if it were on a pipe?

A When the core is metallic it serves as a conductor.

Mr. Werlin testified about specific patents in the following manner:

Q Let me just ask you quickly, do you agree that what is shown in Figure 8 [Mills Patent] is a semi-cylindrical zinc anode?

A Yes, it appears to be.

Q Now, semi-cylindrical zinc anodes are relevant to the subject matter that is to be patented, isn't that right?

A Yes.

* * * *

Q Would you look at the next patent, the patent of Douglas in there? That's another one of the patents that were sent to you, I believe, by Mr. Cockfield, is that right?

A Yes.

Q Before the patent application was filed?

A Yes.

Q Does that patent disclose an anode which has two parallel core bars in it?

A Yes.

Q And the ends of those bars protrude from the opposite edges?

A Correct.

Q And those bars are used to fasten it to the object that this anode is to protect?

A Yes, sir, I think so. I haven't read this patent, but I'm sure that's right.

Q And the core bars are adjacent to one face of the anode, isn't that correct?

A Yes.

Q Now, your claim, if you will look at the patent in suit, the first patent in the book of patents there, your Claim 1 says that the metal core — that's sub-paragraph 2 — is cathodic to the anode metal, and that's true of the metal core in the Douglas patent, isn't it?

A I assume so. As I say, I haven't read the patent. It would appear that's right.

Q And it's imbedded entirely within the anode metal, is that correct?

A Yes.

Q And the core comprises two axially spaced parallel metal bars, is that correct?

A Yes.

Q And the bars have end portions which project from opposite longitudinal edges of the anode body, is that correct?

A Yes.

Q And they form joint elements for connecting this anode to whatever it is going to protect, is that right?

A I believe that's correct. As I say, I haven't read it, but it would be logical.

Q It would be, then — you would agree that that's relevant to the subject matter, to the patentability of the subject matter of your patent, is that right?

A Yes, I would assume any — almost any anode would be.

Q The Battis patent, B-a-t-t-i-s, which is the next patent in the book there, 3,001,924, it's similar in structure to the Douglas patent, isn't it?

A Yes. Yes, I think so. Looking at the drawing, I would say so.

Q And your answers with respect to the Battis patent, if I were to ask the same series of questions that I did about the Douglas patent, would be essentially the same, isn't that correct?

A Yes.

Q Now, the next patent in the book there, 3,240,512, is a patent of Pennington, et al., which I will clarify, for the Court, it is not Dr. Pennington, who is my expert witness here.

* * * *

Q That is another patent that was sent to you by Mr. Cockfield before your patent application was filed, is that correct?

A Yes.

Q That patent shows two semi-cylindrical members of concrete, isn't that correct?

A It appears to be.

Q And they have a metal core in them, too, don't they?

A Yes, there is a metal liner.

* * * *

Q And that's generally the same manner as the cores in your patented anode are welded together at their adjacent edges, isn't that correct? Adjacent halves, the two semi-circular halves.

A Yes. Each has a metal element that's welded together. . . .

* * * *

Q Now, look at the next two patents in the book there, with the white tabs on them, the patents for Wesley, No. 2,303,778, and 2,656,314, Osterheld, O-s-t-e-r-h-e-l-d. Do you recognize those as the patents that the patent office cited in the first office action on your application?

A . . . .

Yes, those cited by the patent office.

Q What do they show that is relevant to the patentability of the subject matter of the patent in suit?

A Well, I'm, frankly, going to have to guess at it, it shows something about more noble and less noble metals.

* * * *

Q Now, what do those disclose that is relevant to the patentability of the subject matter of the application you filed?

A I looked those over, and looked at the action of the patent office, and those were referred to only in connection with Claim 6, I believe it was, which had to do with the shape of the ends of the metal straps, one being offset with respect to the other, so that they could be more easily coupled. And that's the only reference that these patents seemed to have to the application as filed. And, so far as I can tell, they had very little relevance to what we were concerned with.

* * * *

Q Let's go to the next patent in the patent book that you have there, the patent to Harris . . . .

* * * *

A . . . . It says "galvanic anode," and it shows a bar of what I presume to be galvanic material with a rod through it. . . .

* * * *

Q If you look at Column 3, Line 26 of the patent, the language there says, "An anode which possesses the foregoing features is illustrated in the accompanying drawings where the rod-like anode body 1 is of circular cross section."

Did I read that correctly?

A That's right.

* * * *

Q The next sentence after that says, "Concentrically embedded in the anode and extending beyond the ends thereof is wire 2," . . . .

A Yes. . . .

Q . . . . Let's go down further in Column 3, to Line 49, and the sentence there says, "In cross section the anodes may be round or polygonal," . . . .

A Yes.

Q . . . . Now, you will look at Figure 4, and you will see in that figure the anode has been bent into a semi-circle, has it not?

A Yes, sir. . . .

* * * *

Q But, at least so far, what we have is an anode body, and we have a generally semi-cylindrical segment, don't we?

A Yes, but you have what appear to be either polygonal or cylindrical.

* * * *

Q . . . . We have already, concentrically embedded in there we have a core, don't we? This wire comprises a core in this structure, doesn't it?

A It can be called that, certainly.

Q And if we go to the top of Column 4, Line 11, it says, "The embedded wires or similar members serve both to mechanically connect the separated segments and as electrical conductors from the anodes to the tank or or [sic] metal body being protected." That's the same way that the core structure in the patented anode is used, isn't it?

A Yes.

* * * *

Q And if we go further down Column 4, it says, "It is preferable that the wire be concentrically positioned in the anode, but this is not essential —" . . . .

. . . is that correct?

A I'm sure it could be put any place in those rods.

Q The patent says so?

A Yes.

Q And then down to Line 44 in Column 4, it says, "In some cases it may be desirable to employ two or more core members, providing they are in the same plane," and you have two or more core members in the patent, you have got two parallel bars, right, in the patented anode?

A Yes, sir.

* * * *

Q Let's go to the patent to Sabins, No. 2,826,543.

Q That patent is also about anodes for cathodic protection, isn't it?

A Yes.

* * * *

Q. And it says that the core includes a pair of laterally spaced longitudinally extending core rods, and it says they are interconnected by transverse, or weldably connected, actually, together by a plurality of transverse members or spur rods. Is that correct?

A Yes.

* * * *

Q Okay, let's look at the last patent in the book, the patent of Godfrey, No. 2,067,839. . . .

* * * *

Q As you can see, by looking at the drawing, particularly Figure 3 of the drawing, what the patent dis-

closes is a cylindrical member which is composed of two semi-cylindrical segments which are held together by a couple of bolts, is that right?

A That appears to be correct, yes.

* * * *

Q The core in there is concentric with the outer zinc portion, isn't that correct?

A Yes.

Dr. Pennington testified as follows:

Q Now, from your study of the prior art that you have seen, which you heard Mr. Gordon Doremus testify that he knew about before the original application was filed and before the original patent was issued, do you find those elements that you have just talked about within any of that prior art?

A Yes, I heard him testify about the Mills patent, that's Mills 800, and it does have the semi-cylindrical form of a body, or a galvanic anode. He also testified about a ball-shaped anode, which consisted of two semi-circle halves, which I believe was to be put on to things such as boat shafts. So in both of these cases, there was art of which they were aware, which did show semi-cylindrical bodies.

Q All right, sir, how about the next one, the core embedded entirely within the anode and adjacent the periphery?

A That appears in, for instance, these hull anodes, at least one of which is on the table and is an exhibit.

Q This one here, Exhibit 53?

A Plaintiff's Exhibit 53. The cores there, or core, is entirely embedded in the anode material, and is adjacent to the inner — to one side. Also, some of the

patents that they have at that time show the same sort of thing. I'm thinking particularly of the Battis patent and the Douglas patent, both of which have cores completely, or entirely, embedded in the body, and adjacent one side.

Q How about this one at the bottom here, opposite longitudinal edges, where the end portions of the core bars project from the opposite longitudinal edges of the anode body?

A Those are found in the art that I just mentioned, namely, in the hull anode and in patents such as Battis and Douglas.

* * * *

Q In the prosecution of this application for reissue, what was emphasized as the principal distinction over the prior art?

A The thing that is mentioned over and over again is having a core completely embedded in the anodic material.

Q And what do you find in the prior art with respect to the complete embedding of cores in the anodic material?

A That was, really, the general practice. This is the way it's done.

Q Can you give us just a couple of examples, please?

A I mentioned the hull anode as an example, Mills has it, Battis has it, and the patent to Godfrey has it, except that there is an inside part of it that goes against the shaft and is not embedded. The Mills spec, and by the Mills spec I mean that exhibit we have of a military specification showing hull anodes and other kinds, it has it. In fact, all the way

through, page after page, you see anodes in which the cores are completely embeddel in the anodic material.

* * * *

Q All right. Can you tell us whether there are any features described — let's take Claim 1 of the original patent, for example — which are not disclosed in the Godfrey patent?

A The thing I mentioned about the completely embedded — one could take the position that this core in Godfrey is completely embedded. However, it could be argued that it is not, because there is a face of it which depends for its coverage on the item to which it is to be attached. However, in effect it is completely embedded.

The reading of the claim we have, "a pair of semi-cylindrical segments adapted to embrace a—" it could be a pipe, it could be anything round, "each segment comprising a continuous semi-cylindrical body of galvanic anodic metal," we have that, definitely. "A metal core cathodic to the anode," and this metal core is made of steel, or can be made of bronze, it depends on what you are going to protect with it. However, it is "cathodic to the anode," which is made of zinc, magnesium or aluminum," entirely within, adjacent the inner periphery of said body." Well, certainly it is adjacent to the inner periphery of said body, just as one piece of property is adjacent to another. "Said core comprising at least two axially spaced parallel metal bars," which I read on Element 21, in Figure 5 and Figure 6, "A plurality of angularly spaced metal rods interlinking said bars." We do not have that, in those words. It's interlinked, but it's not in the form of the three bars.

Q It's a single sleeve?

A It's a single sleeve. "—each of said bars having end portions projecting from opposite longitudinal edges of the anode body to form joint elements." It could be argued that here we do not have them extending out, but we do have the equivalent in the form of a joint member. In this case it's a cap screw into a hole in one member and a threaded hole in the other member, one on each side.

Q Dr. Pennington, in plaintiff's testimony, you heard, or I believe you heard that they — Mr. Doremus, particularly, testified that in his opinion a segmented, a quarter section, quarter circle, or an eighth circle was, in effect, the same thing as a semi-cylindrical member, is that right? Do you recall that testimony?

A I recall that testimony, yes.

Q All right. If you were to assume that a continuous semi-cylindical body of anodic metal and a continuous quarter circle or eighth circle of galvanic anode metal are all the same, what effect would that have on this claim?

A Well, the effect it would have on that claim would be to wipe out that word semi-cylindrical in Line 45.

Q This line here?

A That line there.

Q They also testified that it didn't make any difference whether you had two core bars or one core bar, it was the equivalent. What would be the effect of that on this claim?

Q Well, the effect of that would be to wipe out some material therein, first of all in 3, sub-A, we would have a metal bar, instead of —

Q A metal bar?

A A metal bar.

Q So we'll mark off the two right here and leave "a," and mark the "s" out of bars. No, I went too far, I shouldn't have marked out "metal."

A That's right, I'm sorry, I misled you on that.

Q Now, they also testified it didn't make any difference whether you had angularly spaced metal rods?

A Yes, but before we get to that, I have one more thing to say in connection with the last question.

In 3-C, the words "each of" would no longer be pertinent, and take the "s" off the end of the "bar." We would have "said bar having —"

Excuse me, Counselor.

Q That's all right. Thank you for that correction.

They also said that it didn't make any difference whether you had the interlinking angular spaced metal rods interlinking the bars, it would still be an infringement without that, didn't they?

A Yes, I heard that testimony.

Q Now, what effect does that have on the claim?

A That wipes out 3-B, completely.

Q And they went further and said that if it comes out of the sides, if the bars come out the sides, it, in effect, is the same thing as coming out of the opposite longitudinal edges, isn't that right?

A That's right.

Q What effect does that have on this claim?

A That would affect — in 3-C we have, "projecting from." Now, it would strike out "longitudinal edges of."

Q "Opposite longitudinal edges of"?

A Yes. So that the 3-C would now read, "said bar having end portions projecting from the anode body," et cetera.

Q If that claim has been modified by the plaintiff in order to read it on the designs that are accused of infringing, what are the differences between that claim and the claim that was originally filed in the first application?

A It's very similar, inasmuch as the original claim, No. 1 was combined with No. 5, which gave the core structure. Now, we have kind of played havoc with this Claim 5 part, namely, the core structure, which leaves us primarily with what — just what was in rejected Claim 1 of the original application, and which was passed up, they gave that up.

Q This claim now, as in this form, would you say that the prior art discloses anything of the nature as defined by this claim as the plaintiff would have us read it?

A Oh, yes.

Q What?

A Well, from the standpoint of patents, you can read that claim now on Harris —

Q The Harris patent? Would you point out the Harris patent to us and show us how that is effective?

A The Harris patent is one of the blue labeled patents in the book, which is Defendants' Exhibit —

Q 32, Defendants' Exhibit 32.

A Thank you. It's the first of the blue-labeled patents, and is Harris, et al, 2,619,455. This was issued in 1952, to a man, or men, who assigned it to Alcoa, Aluminum Company of America. This shows, first of all, a semi-cylindrical — in Figure 4 — a semi-cylindrical, or semi-circular aggregation of segments which have a core running concentrically. This core, it says in the teaching of the patent, can be two rods instead of the one that is shown, if it is desired. This core is completely embedded within the anodic material, except, of course, like all of these, a little bit for connection purposes sticking out the end. And this core that runs concentrically about the — what would be a pipe, if it were put on a pipe, is shown in Figures 2 and 3 to be in the center, but the text of the patent shows that it can be moved to a side.

So you can read this emasculated Claim 1 right on Harris with very little resort to any equivalents of any kind.

Q In other words, you don't even have to have any other prior art or reference at all?

A No, I think Harris has it. But there is other art that comes close to it, and most of it has been touched on a number of times.

Q How about the one shown in Plaintiff's Exhibit 31 that you just looked at a minute ago, the Southern Shipbuilding design?

A It has everything except "totally embracing." I don't want to digress a lot, but as to the meaning of this claim, the claims say "embrace." The text of the specification, when it is talking about the embodiment

shown, and so forth, talks about "completely embraced." So that, in a sentence, then, the claims are broader, when they say "embrace," are broader than "completely embracing."

That is to say, "embrace" would include "completely embracing," a picture of which is shown, and would include "partially embracing." It's a broad term.

Now, the reason for that digression is that Southern Shipbuilding, you have two quarter-circle anodes with concentric cores, the concentric cores are near the inside edge. You do not have four. So that the anodic material does not go all around a complete 360 degrees, it goes 90 degrees, 90 degrees, and then it joins, however, as it has to be, on the other two 90-degree segments. But it does have — anything that could be thought of as an invention here is in that Southern Shipbuilding.

Q Are the Southern Shipbuilding anodes any more or any less adapted to embrace a pipeline than the quarter-circle anodes like Plaintiff's Exhibit 52, and the eighth-circle, like Defendant's Exhibit 34, which are accused of infringement?

A They are equally adapted to embrace. That is to say, the Southern Shipbuilding anodes are adapted to embrace, as shown in the exhibit that I drew up, which was DX—12, was it?

Q You are talking about 17?

A DX—17. So that the anode that was furnished to Southern Shipbuilding years ago, is adapted to do the very job we are talking about through this whole action.

Q That's what the claim says, isn't it, "adapted to embrace a pipeline"?

A Yes. The infringement here is in having these pieces. We do not have them here assmbled exactly, because these pieces are adapted. That is, they are not assembled on a pipeline, they are not pigtails to the pipe. The patent does not go to coating whatever bare metal there is, or any of these things. It goes to these pieces and how they can be put together to make a bracelet.

Q In your opinion, if the patent office examiner had had before him the prior art that we have discussed here today, what should his action have been?

MR. BRESTON: Your Honor, I object to this question, it calls for a conclusion, speculating on the part of the witness as to what the examiner might have done.

THE COURT: I think, in view of his familiarity, I will hear it, Mr. Breston. It will be given proper weight.

A And my testimony will be in direct answer to the question, what he should have done, not what I think he would have done, which, of course, would require mind reading.

He should have rejected it, in view of this art that we have before us in this courtroom.

United States Court of Appeals

FOR THE FIFTH CIRCUIT

No. 76-4134

D. C. Docket No. CA-72-H-1002

CATHODIC PROTECTION SERVICE,

Plaintiff-Appellee,

versus

AMERICAN SMELTING & REFINING COMPANY, FEDERATED METALS CORPORATION and WAYNES BROYLES ENGINEERING COMPANY,

Defendants-Appellants

Appeal from the United States District Court for the Southern District of Texas

Before GEE and VANCE, Circuit Judges, and HUNTER*, District Judge.

J U D G M E N T

This cause came on to be heard on the transcript of the record from the United States District Court for the Southern District of Texas, and was argued by counsel;

ON CONSIDERATION WHEREOF, It is now here ordered and adjudged by this Court that the judgment of the said District Court in this cause be, and the same is hereby, reversed; and that this cause be, and the same is hereby remanded to the said District Court in accordance with the opinion of this Court;

It is further ordered that the plaintiff-appellee pay to the defendants-appellants the costs on appeal, to be taxed by the Clerk of this Court.

May 7, 1979

*District Judge of the Western District of Louisiana, sitting by designation.

ISSUED AS MANDATE:

NO. 76-4134

U. S. COURT OF APPEALS
FILED
JUL 2 1979
EDWARD W. WADSWORTH
CLERK

CATHODIC PROTECTION SERVICE,

Plaintiff-Appellee,

versus

AMERICAN SMELTING & REFINING COMPANY, FEDERATED METALS CORPORATION and WAYNES BROYLES ENGINEERING COMPANY,

Defendants-Appellants.

Appeal from the United States District Court for the Southern District of Texas

ON PETITIONS FOR REHEARING

(July 2, 1979)

Before GEE and VANCE, Circuit Judges, and HUNTER, District Judge.*

PER CURIAM:

IT IS ORDERED that the petitions for rehearing filed in the above entitled and numbered cause be and the same are hereby Denied

ENTERED FOR THE COURT:

United States Circuit Judge

*District Judge, of the Western District of Louisiana, sitting by designation.

PLAINTIFF'S EXHIBIT 18

CATHODIC PROTECTION OF SUBMARINE PIPELINE

Federated Hi-Amp Zinc Application

reprinted from FEDERATED METALS DIGEST

ASARCO

FEDERATED METALS DIVISION

AMERICAN SMELTING AND REFINING COMPANY
120 BROADWAY • NEW YORK 5, NEW YORK

Bulletin 191

This article presents a case history application of the new Federated Hi-Amp Zinc Alloy anodes



Cathodic Protection of Submarine Pipeline

AN UNUSUAL application of sacrificial zinc anodes is helping Tennessee Gas Transmission Company insure cathodic protection for a 21-mile, 26-inch underwater natural gas pipeline off the coast of Louisiana.

Normally, with a moderately good concrete coating on the submerged pipe, protection could be expected from the rectifier installed at the onshore end and the magnesium used at the offshore, or platform end, of the pipeline. But, it was decided as an insurance measure to provide additional maintenance-free protection for the line's 10-mile center section.

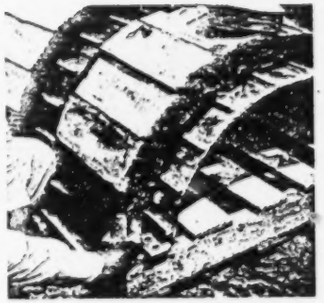
This additional protection, the result of an idea and design developed by TGT's corrosion engineering department, involved grouping anodes into sleeves which were then clamped to the pipe before it was buried under the Gulf's bottom.

Federated Hi-Amp zinc anodes, a new zinc alloy developed by Asarco research, was suggested and adopted for this installation. The anodes were cast at the company's Houston, Texas, plant. Brance Krachy Co., Inc., a Federated distributor in Houston, collaborated in the production of the anodes for TGT.

The new alloy had previously performed well in long term quiet immersion tests and shipboard trials. These tests revealed that the Hi-Amp anodes maintained effective current output for their full lives, which made them particularly suitable for the submerged section of the pipeline providing a virtually maintenance-free installation.

TGT's corrosion experts estimated that 21,000 pounds of zinc would be required to protect the line for its 40-year design life. The installation consisted of 21 anode sleeves installed directly on the pipe at half mile intervals. Each sleeve contained twenty 50-pound zinc alloy anodes specially designed for this installation by Federated's Houston Plant in association with TGT and Brance Krachy. This provided the most economical and effective anode shape and size.

The anodes were cast 4 inches wide, 3½ inches thick and 14 inches long with square steel cores protruding several inches at the ends. Tapered sides enabled 20 anodes placed side by side to form a snug sleeve around the circumference of the pipe. After installation, the outside of the sleeve was flush with the adjacent concrete coating applied to the pipe.



Half of anode sleeve shows steel cores of zinc alloy anodes welded to steel bands.

A sleeve was made up of two steel half rings bolted together. Each half ring was assembled by welding the protruding steel cores of 10 zinc anodes, placed side by side, to two semicircular steel bands. The end of each band extended out at a right angle for about two inches and contained two bolt holes. Insulating tape was then wrapped over the entire inner surface of the assembled half rings and insulating material was poured between the zinc alloy anodes. Several thicknesses of plastic tape were wrapped around the outer felt pipe-wrap under each anode sleeve as insurance against mechanical damage to the coating.

After the two half rings were bolted around the pipe, they were electrically connected to the pipe using a short length of cable. All connections were thermit-welded.

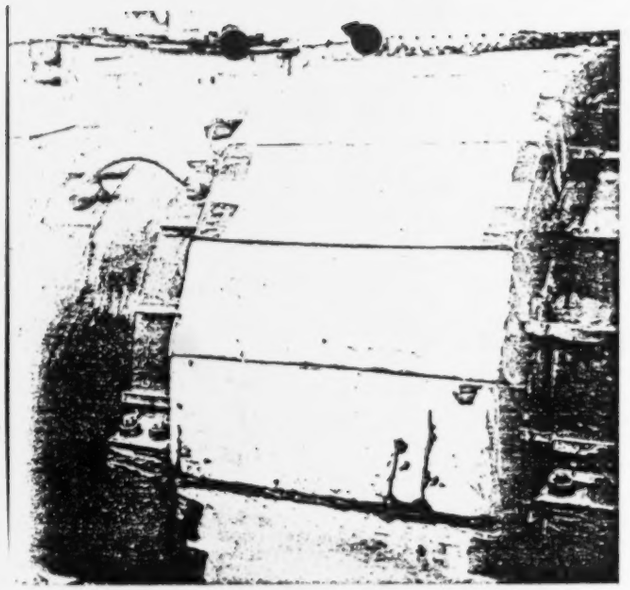
The zinc installations, as designed, will allow less current to be furnished at either end of the line. As previously mentioned, magnesium anodes protect the accessible portion of the line at one end and an impressed current anode system is used at the other end. The use of zinc makes possible predicted maximum cathodic potentials of 1.1 volts anodic to a copper sulfate electrode, thus reducing the possibility of electrical damage to the protective coating. While serious damage of the coating was not anticipated in laying the pipe, the anodes were expected to provide adequate protection for such breaks.

Development of the Hi-Amp zinc anodes used in this installation was preceded by studies of zinc anode performance on commercial size materials. Their big drawback was accumulation of dense surface film with high electrical resistance. The dense film stopped current flow from the zinc anodes after several months service, rendering them ineffective.

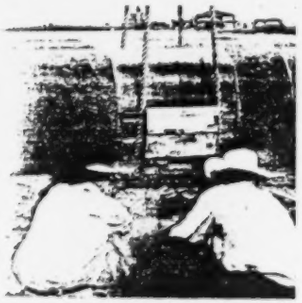
Work conducted several years ago by others revealed that minute iron impurities caused this problem. Therefore, the specification MIL-A-18001 (Ships) was adopted by the Navy-Bureau of Ships. This specification permitted a maximum of only 0.0014% iron content in zinc anodes. While these studies brought about an important improvement, Asarco research showed that current output of zinc anodes made to MIL-A-18001 (Ships) still decreased with time, although at a reduced rate compared to other zinc anode materials previously used.

The big breakthrough came with the discovery in Asarco's laboratories that adding small quantities of aluminum and cadmium to the zinc increased its tolerance for iron. This alloy became the basis for Hi-Amp zinc anodes. Full scale tests in marine service demonstrated that current output obtained from them was up to 70% higher than that of the commercial low-iron (0.0014% max.) unalloyed anodes made to Spec. MIL-A-18001 (Ships).

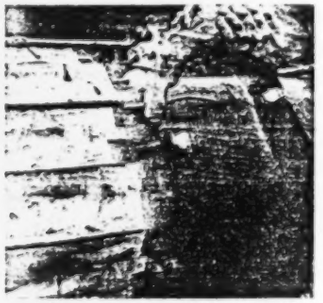
Examination of Hi-Amp anodes under test revealed only a light, loose surface film that did not impede current flow and produced uniform consumption of the zinc alloy until entirely spent. They are now being made in standard marine shapes and sizes. Special designs, such as the pipeline anodes, are made to user specifications on request.



Install zinc anode sleeves at half mile intervals for one-shot protection lasting 40 years. Close-up above shows typical sleeve composed of 20 zinc alloy anodes weighing 50 pounds each. Wire loop electrically connects anodes and sleeve to pipe.



Lower half of sleeve being installed. Plastic tape around pipe helps prevent pipe coating damage.



Cable is thermit welded to anode sleeve. Other end is welded to pipe in cut-out area.

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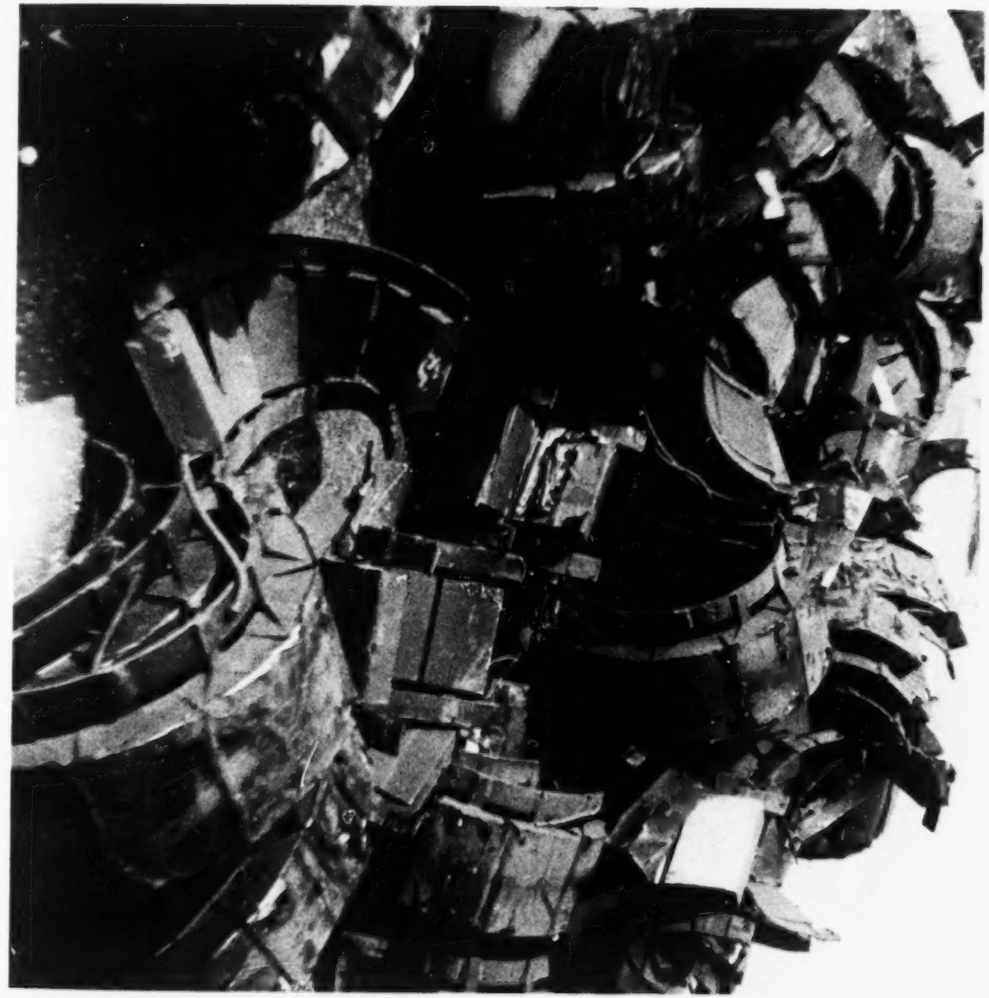
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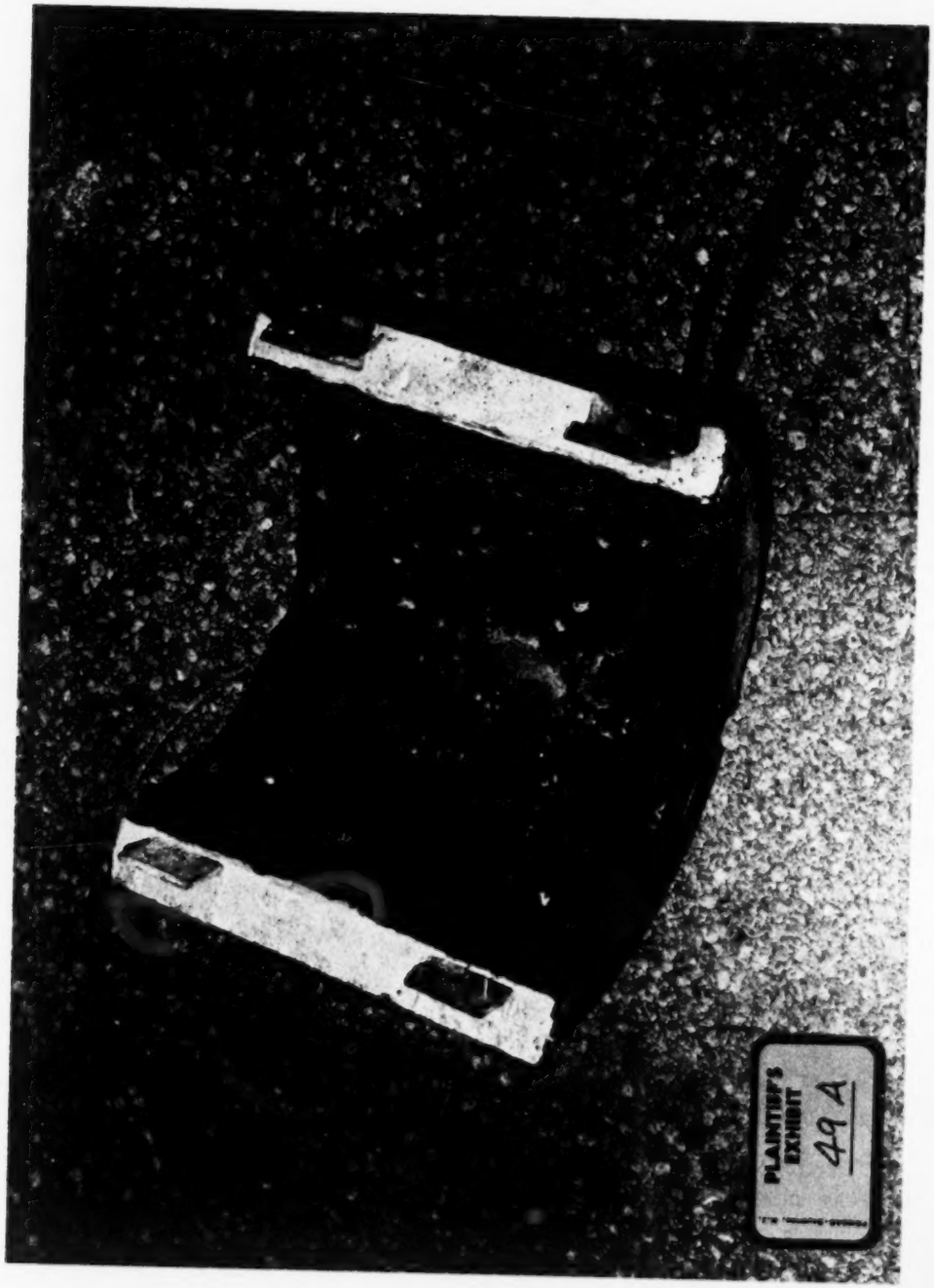
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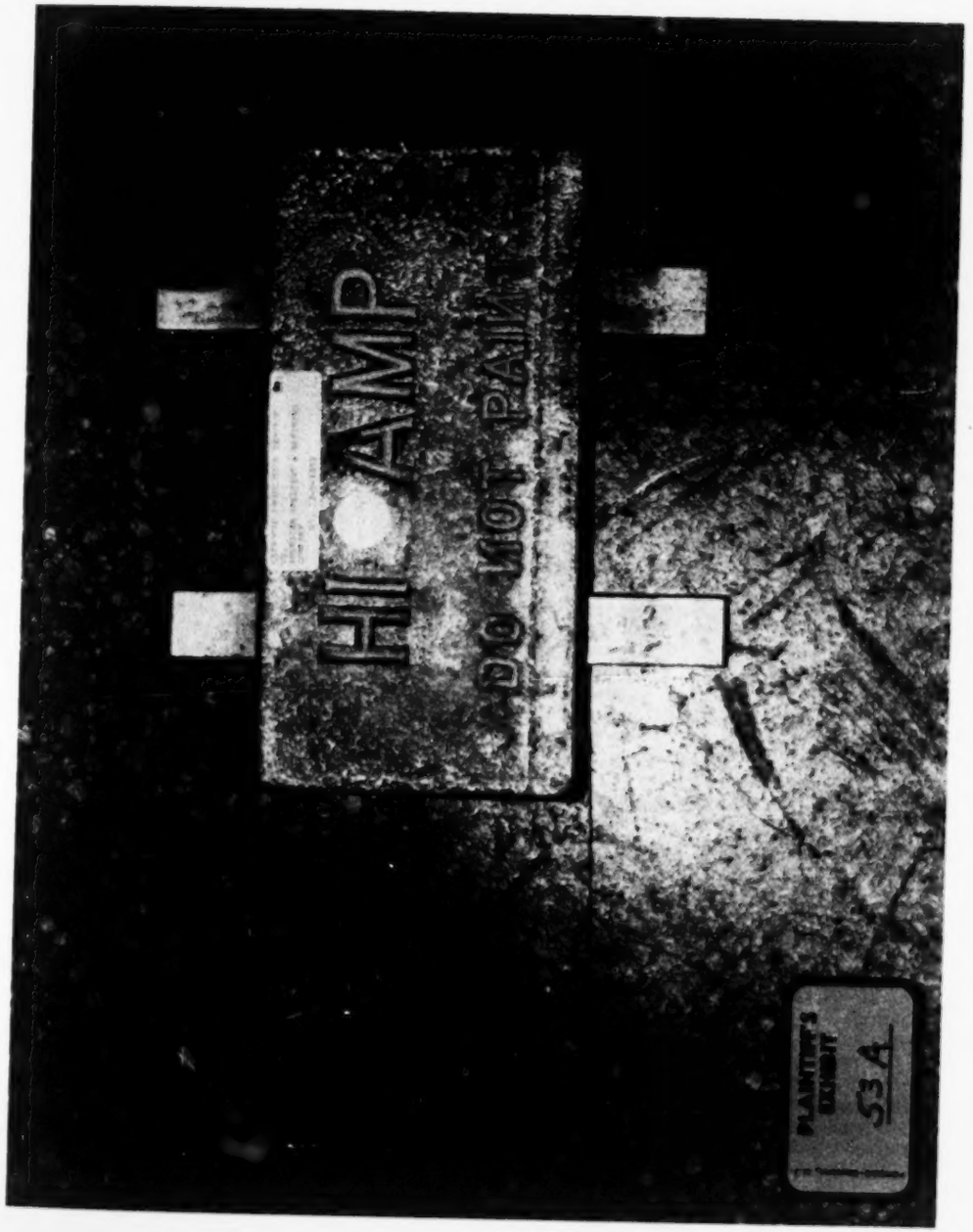
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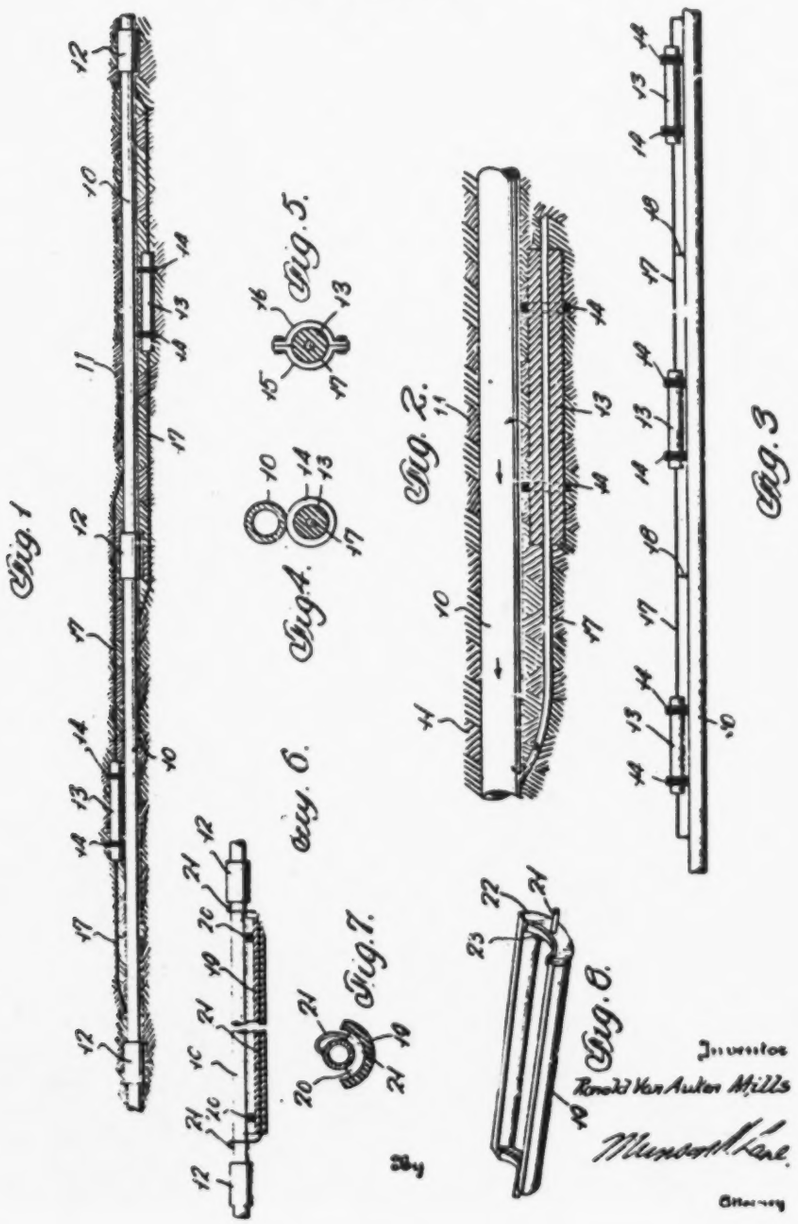

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April 3, 1928. 1,664,800

R. VAN A. MILLS

ELECTROCHEMICAL METHOD OF AND MEANS FOR PROTECTING BURIED PIPE LINES AGAINST CORROSION

Filed Dec. 5, 1924



Patented Apr. 3, 1928. 1,664,800

UNITED STATES PATENT OFFICE.

RONALD VAN AUKEN MILLS, OF SANDY SPRING, MARYLAND, ASSIGNOR TO PETER G. NYCE, OF WASHINGTON, DISTRICT OF COLUMBIA.

ELECTROCHEMICAL METHOD OF AND MEANS FOR PROTECTING BURIED PIPE LINES AGAINST CORROSION.

Application filed December 5, 1924. Serial No. 754,187.

The invention relates to an improved method of and means for protecting buried or submerged pipe lines against corrosion.

It is well known that corrosion is essentially an electro-chemical process, largely dependent upon galvanic action, and that corrosion occurs on electro-positive surfaces, that is to say, the surfaces from which an electric current leaves a metal and passes into an electrolyte, such as water and its dissolved constituents.

Corrosion of buried pipe lines is made possible by the presence of water in the ground. The present invention aims to prevent this type of corrosion.

Accordingly, I provide zinc or other metal which is electro-positive to iron, in close proximity to the pipe line, whereby the piping is rendered electro-negative with respect to the zinc or other protecting material, and corrosion then takes place on the surface of the zinc or other protecting substance instead of upon the pipe.

It is further desirable in many cases to avoid direct metallic contact between the piping and the zinc or other protecting material. The disadvantages of the direct contact are two fold. First, the protection is localized, only the surface in the immediate vicinity of the zinc being protected. Secondly, short circuiting or contact action takes place between the piping and the zinc, which gives rise to rapid consumption of the zinc.

According to the present invention, I eliminate these disadvantages by placing the zinc in close proximity to, but not in direct contact with, the pipe line and also by providing non-conducting spacers between the electro-positive protecting material and the pipe line. An electric circuit between the pipe and the protecting material is completed by connecting the zinc to the pipe line by means of suitable conductors or bonds, which may be wires or metal rods. The bonds may be welded or clamped to the pipe.

The invention will be more readily understood by reference to the accompanying drawings in which:

Fig. 1 is a plan view representing a horizontal pipe line buried beneath the earth ing devices located at intervals along the length of the piping.

Fig. 2 is a detail view partly in plan and partly in longitudinal section, showing one of the protecting devices of the type shown in Fig. 1.

Fig. 3 is a plan view similar to Fig. 1 showing a number of the protecting devices placed at intervals along a single conductor, which is parallel to the line of pipe and connected to the pipe at intervals by suitable bonds.

Fig. 4 is a detail cross-sectional view through one of the protecting devices illustrated in Figs. 1, 2 and 3, showing one of the spacing devices in elevation.

Fig. 5 is a detail similar to Fig. 4 but showing a removable spacer.

Fig. 6 is a view partly in side elevation and partly in longitudinal section, showing a portion of pipe line having a trough-shaped protecting device located beneath the pipe line and separated therefrom by suitable spacers.

Fig. 7 is a cross-sectional view of the same, and

Fig. 8 is a perspective view showing a further modification of the protecting device, which is trough-shaped as is Fig. 6, but is provided with integral end members upon which the piping rests.

Referring first to Figs. 1, 2 and 4, the reference numeral 10 represents a horizontal pipe line, ordinarily composed of iron or steel, which is buried in the earth 11, and is provided with the usual collars 12 at junctures of the successive lengths of piping.

In order to prevent corrosion of the piping, protecting elements 13, composed of material which is electro-positive with respect to the piping, are located at intervals along the pipe line. These protecting elements 13 are composed preferably of zinc, though any metal which is electro-positive with respect to the piping may be used. As shown in Figs. 1, 2, 3, 4 and 5, these elements are in the form of solid cylinders or short rods though other forms may be used if desired.

In order to prevent short circuiting between the rods 13 and the pipe line, I preferably provide non-conducting devices 14

surrounding the electro-positive elements 13, or may be formed in two parts 15, 16, as shown in Fig. 5, or may be in the form of blocks or other convenient form. These non-conducting collars may be of any suitable material, as terra cotta, porcelain, bakelite, or the like.

An electrical circuit is completed by means of suitable conductors 17, which may, if desired, be cast within the electro-positive elements 13, and secured at their ends to the pipe line 10 in any suitable manner, as by spot welding or clamping.

In Fig. 3 a single conductor 17 is used, which extends parallel to the pipe line 10 and is provided with a plurality of protecting devices 13 located at spaced intervals. The conductor is connected to the pipe line by means of suitable bonds 18.

In Figs. 6 and 7, is shown a modified protecting device which is adapted to be placed beneath the pipe line 10, and is preferably in the form of a trough 19 which is separated from the pipe line by means of suitable insulating spacers 20, and electrically connected to the piping by means of suitable conductors 21. The advantage of this type of device is that moisture will collect in the troughs 19, thus providing an electrolyte which promotes galvanic action. In the forms previously described the moisture normally present in the earth must be relied upon. In some cases there is sufficient moisture at certain parts of the pipe line to produce corrosion but not sufficient moisture at the points where the protecting devices are located to produce the galvanic circuit which is necessary to the operation of the device. In such cases the trough-shaped members should be used in preference to the rod-shaped form previously described.

In Fig. 8 a still further modification is shown in which the trough 19 is provided with raised ends 22 which increase the holding capacity of the trough and further insure galvanic action between the pipe to be protected and the electro-positive protecting devices. According to this modification spacing devices 23 are interposed between the ends 22 of the trough and the pipe itself.

The protective action of the electro-positive elements will be evident from the foregoing description. The presence of corrosive liquids in the earth produces galvanic action as shown in Fig. 2. An electric current flows from the electro-positive surfaces of the protecting elements 13 in the direction of the arrows to the electro-negative surface of the pipe line, along which it flows, the circuit being completed by means of the conductor 17. The operation is the same in the other forms of the device shown.

In this manner only the electro-positive elements are corroded, the pipe line being protected. Eventually the protective devices will have to be replaced, but this can be done at a very small cost as compared with the expense involved in replacing an entire pipe line.

To replace the protecting elements, it is only necessary to provide terra cotta or other piping leading from the surface down to the original protecting elements, said piping being of sufficient diameter to allow a new protecting element to pass down and rest in contact with the original protecting element or the conductor to which the original element was secured.

The invention has been described in considerable detail for the purpose of illustration, but many further modifications will be evident to one skilled in the art, without departing from the spirit of the invention.

For example, rings or sleeves of zinc surrounding the piping but spaced therefrom, may be provided, such rings being located at spaced intervals along the length of the piping, and connected thereto by means of suitable conductors.

I claim—

1. A device for protecting buried iron or steel piping against corrosion, comprising a zinc protecting element buried within the earth in intimate contact therewith and in close proximity to said piping, but spaced therefrom by means of non-conducting spacers, and conductors for completing an electric circuit to said piping at a distance from the protecting element.

2. An electro-chemical method of protecting buried piping against corrosion, which consists in applying a metal electropositive to the piping on the outside of the piping and in intimate contact with the earth, spacing the electro-positive metal away from direct contact with the piping and electrically connecting the electro-positive metal to the piping at a substantial distance therefrom.

In testimony whereof I affix my signature.

RONALD VAN AUKEN MILLS.

Dec. 1, 1942. A. WESLEY 2,303,778

SOIL PIPE

Filed March 4, 1941

Fig. 1.

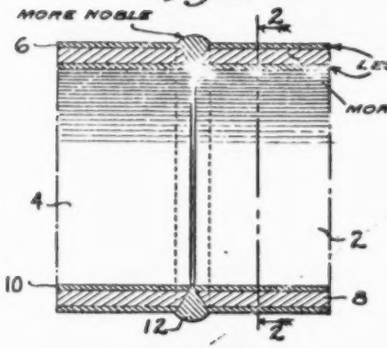


Fig. 2.

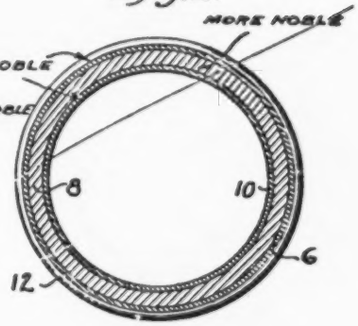


Fig. 3.

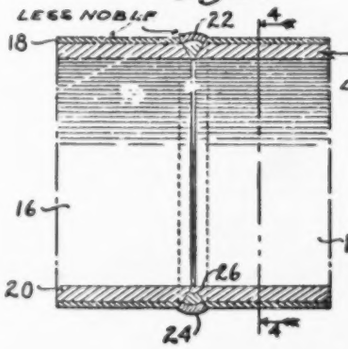


Fig. 4.

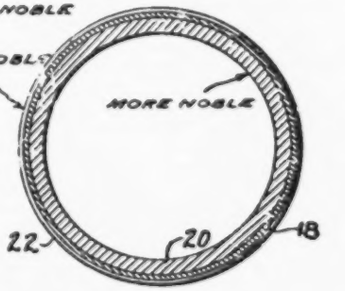
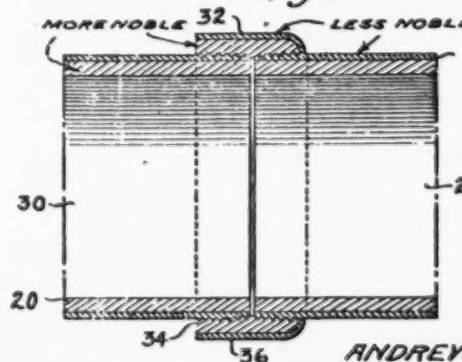


Fig. 5.



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ANDREW WESLEY
BY A. P. Deller
ATTORNEY

Patented Dec. 1, 1942 2,303,778

UNITED STATES PATENT OFFICE

2,303,778

SOIL PIPE

Andrew Wesley, Plainfield, N. J., assignor to The International Nickel Company, Inc., New York, N. Y., a corporation of Delaware

Application March 4, 1941, Serial No. 381,627
In Canada February 6, 1941

4 Claims. (Cl. 138—44)

The present invention relates to a soil pipe which resists penetration by corrosion, and, more particularly, to a soil pipe made of composite ferrous layers having a critical relation of potential differences between the exposed layer and the under layer in which the less noble layer is exposed to the corrosive material.

It is well known that metal pipes buried in soil are subject to corrosion which proceeds non-uniformly over the exposed surfaces. The researches of the Underground Corrosion Division of the National Bureau of Standards, for example, have shown that in the corrosion of iron and steel buried in the soil, the rate of deepest pitting in most soils is 7 to 10 times greater than the penetration by general corrosion. Non-uniform eating away of the metal causes far greater economic loss than would result from uniform corrosion over the entire exposed area even though the weight of the metal lost in the case of uniform attack is greater than in the case of localized corrosion. Penetrating pit formation resulting from non-uniform attack materially shortens the useful life of a pipe and enormous outlays must be made in the maintenance of long pipe lines for conveying water, gas, oil, gasoline, etc., where it is the occurrence of perforation of the pipe by the deepest pit rather than the slow general corrosion which determines when a length of pipe must be removed.

It has been proposed to construct pipes of alloy steels but experience proved that any increase in life due to enhanced resistance of such steels to corrosion was too small to be economically justifiable. The alloy structural steels, moreover, were susceptible to non-uniform corrosion to much the same relative degree as plain carbon steels.

It has also been proposed to construct pipes of coated metals having a thin layer of metal more noble than iron or steel which was exposed to soil or other corroding agent. Unfortunately, such composite metals suffered from the disadvantage that their usefulness depended upon the integrity of the corrosion resistant layer because if there were discontinuities in the coating metal initially, or if discontinuities developed in service, so that the base or foundation metal of iron or steel was exposed to the action of a corroding medium, the attack proceeded at such points in the foundation metal even faster than would have occurred in the absence of the more noble coating. Insidious in nature, the extent of the attack in the base metal was often hidden behind the layer of exposed metal in which a mere pinhole was perceptible whereas the base structural metal was eaten away over a large area due to the electrolytic relations of the two metals. Inasmuch as the pipes were almost entirely dependent upon the base structural metal for strength, detrimental and dangerous weakening of the structure resulted from such non-uniform corrosion, and in some instances failures occurred and of course leakage developed. The cost of steel coated with more noble metal was very high compared with plain carbon steel and was practically prohibitive commercially.

The development of a satisfactory material of construction for soil pipes has been a major problem facing the art.

I have discovered that pipes possessing adequate strength and satisfactory resistance to penetrating pit corrosion may be constructed by using composite ferrous plates provided the individual layers of the composite plate are thick enough to contribute appreciably to the strength of the structure and the layer exposed to the corroding medium is anodic with respect to the underlying layer.

It is an object of the present invention to provide a pipe which will be resistant to perforation by localized corrosion.

It is another object of the present invention to provide composite ferrous pipes comprising two or three layers of metal having different electrochemical potentials and the less noble metal is exposed to the corroding agent or agents.

It is a further object of the invention to provide pipes made of composite steel plates resistant to penetration by localized corrosion in which the individual layers of steel forming the composite pipe are of substantial thickness, each layer contributing appreciably to the strength of the structure.

It is also within the contemplation of the invention to provide pipes in which those parts that are exposed to corrosion from only one side, e. g., from the soil, are made of composite metal having two layers of ferrous metal with different electrochemical potentials, the less noble of the two being exposed to the pitting corrosive.

The invention likewise contemplates the provision of pipes in which those parts that are exposed to pit corrosion from both sides are made of composite metal having three structural layers of ferrous metal, the exposed layers being less noble than the central layer.

Other objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 represents a fragmentary longitudinal section of a three layer pipe line adjacent to a welded joint;

Fig. 2 is a cross section of the pipe shown in Fig. 1 taken along the line 2—2;

Fig. 3 illustrates a fragmentary longitudinal section of a two layer pipe line adjacent to a welded joint;

Fig. 4 is a cross section of the pipe illustrated in Fig. 3 taken along the line 4—4; and

Fig. 5 depicts a fragmentary longitudinal section of a two layer pipe line adjacent to a coupled joint.

Generally speaking, the invention comprises pipes made of composite structural plates of ferrous metal, preferably steel, the layers of which are sufficiently thick to contribute appreciably to the strength of the structure and which have different electrochemical potentials. The layers are so arranged that the less noble layer is exposed to the pitting corrosive.

Referring now more particularly to Figs. 1 and 2 of the drawing, it will be seen that the fragment of the pipe line illustrated includes two lengths of pipe designated by reference numerals 2 and 4, each of which is made of a composite plate comprising an outer layer 6, an intermediate layer 8 and an inner layer 10. The two lengths 2 and 4 are joined together by a weld 12. The exposed layers 6 and 10 are of appreciable thickness and strength and are not to be confused with thin, weak protective layers such as galvanized coatings, electro-deposited coatings, and the like. Layers 6 and 10 are respectively exposed in use to the corrosive action of the soil and the contents, such as salt water contaminated mixtures, which attack metal non-uniformly with the production of corrosion pits. In accordance with the principles of the present invention, layers 6 and 10 are made of steel less noble than layer 8. For example, in making a pipe having a wall thickness of about 0.3 inch layer 8 may be made of an alloy steel about 0.16 inch thick containing about 1% of copper and about 2% of nickel, and layers 6 and 10 may be plain carbon steel about 0.07 inch thick. Similarly, layer 8 may be steel of the S. A. E. 2515 type, an alloy steel containing about 5% of nickel, and layers 6 and 10 may be a plain carbon steel, the thickness of the layers again being about 0.16 inch for layer 8 and 0.07 inch for layers 6 and 10. In both cases, the layers 6 and 10 are anodic with respect to layer 8, i. e., layers 6 and 10 are less noble than layer 8. All layers, moreover, have relatively high physical properties and are sufficiently thick to contribute substantially to the strength of the plates making up the walls of the pipes. The layers 6 and 10 do not consist of a mere thin coating without structural strength, as in the prior art pipes of galvanized or coated steel sheets, but is to be considered as a structural element of the combination. This is commercially practicable in pipes embodying the present invention because the lyers are composed of relatively inexpensive steels having good mechanical properties. Further and important advantages of pipes embodying the present invention are that there is no danger that the layers 6 and 10 will crack or peel off even under severe physical shocks in handling, joining, etc., that corrosive attack is confined to the layers 6 and 10, until they have been substantially all eaten away even though the layer 8 may become exposed to the corroding medium through pits, perforations and the like in the layer 6 or 10, and that the true condition of the pipe may be readily determined by visual inspection since hidden corrosion cannot occur in composite pipes embodying the present invention.

It will be observed from the foregoing that the structural layers of the pipes embodying the present invention are arranged opposite to that of the prior art clad steel structures in which the more resistant layer had been exposed to the corrosive medium, whether soil or fluid. The prior art arrangement was, of course, the natural and reasonable way to attack the problem in the light of existing knowledge and experience with the protection of steel against atmospheric and many other types of corrosion. Soil pipes, however, are subject to the foregoing peculiar and special corrosive conditions which lead to pit formation, and under these special and unique circumstances a cladding of more noble metal deters the attack on the under layer only a relatively short time, i. e., only until it is perforated by pits, after which the attack on the base metal proceeds at an accelerated rate due to the unfavorable relationship of electrochemical potentials of the two layers. By reversing the potentials of the exposed and under layers, and by making both of substantial thickness, the surprising discovery has been made that total life of a pipe line is increased many times. This new and surprising result is obtained, moreover, with cheaper materials which are easily produced in structural shapes and plates and readily fabricated into pipes and pipe lines.

While the mechanism of pit corrosion of duplex pipes having layers of different nobility is perhaps not entirely clear, a probably theoretical explanation is that when a layer of protective metal, e. g., a metal more noble than a base layer of carbon steel, was exposed to a corroding medium and the attack proceeded non-uniformly, as it normally does, pits began to form in the protective metal which eventually reached the less noble layer, e. g., plain carbon steel. As soon as this layer was exposed, localized corrosion proceeded rapidly at these points until both layers were perforated. The two metals formed, in effect, an electric cell in which the base metal was the anode, the protective metal the cathode and the corrosive medium the electrolyte. The base metal was thus anodically corroded at a relatively rapid rate depending upon the electrolyte, the difference in the potentials of the two metals, etc., as those skilled in the art will readily understand. On the other hand, when the less noble layer, e. g., the plain carbon layer, is exposed to the corroding medium as in pipe lines constructed in accordance with the present invention and the attack proceeds non-uniformly, pits begin to form just as above and eventually reach the more noble layer, e. g., the above mentioned copper-nickel or nickel steel, but further penetration is arrested as substantially no corrosion of the under layer of more noble steel can occur until practically all of the outer layer of less noble steel has been corroded away. In other words, instead of pit formation proceeding at an accelerated rate as soon as the outer layer is perforated, as in the prior art structures where the more noble layer was first exposed to the corrodant, it substantially ceases in structures embodying the present invention where the less noble layer is first exposed.

The pipe line illustrated in Fig. 1 is adapted for use in situations where the metal is exposed in use to non-uniform corrosion both by the soil and the contents of the pipe line. Where

the contents are not particularly corrosive or do not attack non-uniformly, a pipe line constructed as illustrated in Figs. 3 and 4 may be employed. The two pipes 16 and 18 are made of two structural layers 18 and 20, preferably of approximately equal thickness although the ratio of the thicknesses is not critical so long as both layers are of sufficient thickness to contribute structurally and substantially to the strength of the pipe. The desirable ratios of thicknesses between the more noble and less noble layers of the pipe will depend upon relative costs, corrosion rates, the stress imposed, and other practical limitations. Generally speaking, the less noble material in duplex pipe will constitute from about ⅓ to ⅔ of the total thickness. For example, in making a pipe having a wall thickness of about ⅜ inch, the outer layer may be made of mild steel about 1/16 inch thick and the inner layer may be made of low alloy steel, such as S. A. E. 2515, of a solution potential more noble than mild steel, also about 1/16 inch thick. Both layers contribute to the strength of the pipe and when the deepest pits penetrate the mild steel layer the more noble alloy steel is exposed but further penetration at that point is arrested or greatly delayed by galvanic protection of the alloy steel due to its contact with the less noble mild steel layer.

The lengths of composite pipe are joined together at their juxtaposed edges or ends to form the pipe line. As shown in Fig. 3, the length of pipe may be joined by welding and in this instance the weld has been illustrated as comprising an outer bead or layer 24 of material substantially corresponding in composition or nobility to the outer layer 18 overlaid on a layer of weld metal 26 having a composition approximately the same as, or at least the order of nobility as the more noble layer 20 of the pipe. It will be apparent to those skilled in the art that in welding together three layer pipes of the type illustrated in Fig. 1 a three layer composite weld may be utilized in which the layers of the weld correspond substantially in order of nobility or composition to the layers of the joined pipes. Ordinarily, however, satisfactory results may be obtained in practice using a welding rod corresponding substantially in analysis or order of nobility to the more noble layer of the pipe.

Other types of joints may be used for connecting the lengths of pipe together to form a pipe line. For example, I have illustrated in Fig. 5 a screwed joint suitable for connecting two lengths of pipe similar to those illustrated in Fig. 3. These lengths, which are designated 28 and 30 are provided with screw threads at their ends and they are connected together by a sleeve coupling 32 in the usual manner. The coupling 32 is preferably made of composite metal having an under layer 34 and an outer layer 36 corresponding to the composite pipes which are to be joined together. The exposed layer 36 is made of the less noble metal. Where the corrosive conditions are not severe satisfactory results may be had where the more noble metal 34 is exposed, as shown at the left end of the coupling. The exposure of the more noble metal 34 will cause some acceleration of the corrosion of the adjacent outer surface of the pipe and where it is desired to avoid this, the end of the coupling may be spun over or otherwise covered with a layer of the less noble metal as illustrated at the right end of the coupling.

Other types of joints, for example, flanged couplings, packed and wiped joints may also be used and these types of joints involve no deviation from standard practice except that in the case of flanged couplings, the flanges and bolts must be made thick enough to last as long as the expected life of the pipe line.

It is essential to the success of my invention that the potential difference between the exposed and the under layer be at least large enough to give effective protection. A 2% nickel steel coupled to plain carbon steel gives an adequate potential difference as do various of the copper-nickel steels when coupled to carbon steels. On the other hand, the potential difference should not be so large as to result in excessive corrosion rates where a portion of the more noble layer is exposed. Large potential differences are not only detrimental from a corrosion standpoint but entail the use of larger percentages of alloying elements and hence increase the cost. In general, low alloy steels appear adequate to provide the necessary difference in nobility. In electrochemical potential tests in which plain carbon steel was coupled with 1% copper-2% nickel steel, the potential difference was about 0.08 volt in a 3% sodium chloride solution. Correspondingly, the potential difference when the 5% nickel steel was coupled with plain carbon steel of the same analysis in the same solution amounted to about 0.11 volt. In general, it is preferable to maintain a potential difference between the layers of more noble and less noble steels employed within the range of about 0.07 volt to about 0.15 volt, as determined by this test, and for practical purposes the potential difference should never exceed about 0.2 volt.

It is evident that under the more important soil corrosion conditions the absolute potentials exhibited by different ferrous alloys may cover a considerable range, the important requirement being that the ferrous alloys selected for the surface and underlying layer exhibit sufficient difference in their potentials to arrest the progress of pits upon the exposure of the underlying layer, as just described.

For most purposes a plain carbon steel is entirely satisfactory for the less noble component and is the cheapest material for the purpose, although it is possible that steels even less noble than carbon steel could be used. Low alloy steels containing nickel or nickel and copper would ordinarily be employed for the more noble layer, as nickel and copper tend to increase the nobility. Production difficulties limit the amount of copper that can be present in the absence of nickel to levels which are scarcely adequate to provide sufficient nobility to be highly effective as the more noble layer when coupled with plain carbon steel. Other elements such as cobalt, molybdenum and the like which render iron more noble may also be employed in the more noble layer but are rather expensive and, except in instances where their effect upon other properties is of value, they appear less desirable than nickel or copper and nickel.

The present invention contemplates the use of two steels or cast irons of different alloy content or structure for the more noble and less noble layers respectively. Thus, where high mechanical properties are desired, two low alloy steels differing in composition to provide the essential difference in nobility could be employed; for instance, a low copper steel could be employed for the

outer, less noble layer or layers and a nickel or copper-nickel steel of higher alloy content than required when carbon steel is employed for the less noble element, could be employed for the more noble layer, the relative amounts of alloying metals being selected to produce the desired difference of potential between about 0.07 and 0.2 volt, as above described.

The composite pipes of the present invention may be manufactured in any commercial manner. For example, composite pipes may be manufactured by assembling clean close-fitting seamless tubes of each of the different metals or alloys desired in the composite pipe and working them, e. g., by drawing, to produce at least good mechanical and electrical contact. Preferably tubes of larger diameter than the final desired size are assembled and hot rolled and/or hot drawn to the desired dimensions. This treatment involving the simultaneous application of heat and pressure results in thorough bonding of the layers of the composite pipe. Fitting by shrinking is another method that may be employed in assembling concentric tubes for direct use or for reduction to smaller size. Composite pipes may also be produced by casting directly to finished size, for example, by centrifugal casting. By properly choosing the composition of the layers making up the composite pipe, the pipe may be made of cast iron or steel or a combination of both, e. g., an outer layer of less noble steel lined with a casting of a more noble cast iron or steel, in accordance with the principles of the present invention which have been set forth herein.

Composite pipes embodying the present invention may also be made, if desired, from composite skelp by welding the longitudinal seams in the manner hereinabove disclosed for the transverse seams 12 and 22, for example. The composite plates from which the skelp is produced may be made by positioning a slab of low carbon steel having a cleaned surface at one side of a mold with the cleaned surface exposed to the casting cavity remaining at the other side of the mold into which the nickel, nickel-copper, or other alloy steel that is to form the more noble layer is then cast to form a composite ingot. A satisfactory bond between the low carbon steel and the alloy steel is formed in this manner and the composite ingot may be rolled into composite plate by the use of conventional equipment, as those skilled in the art will readily understand. It will be understood by those skilled in the art that the preformed slab that is positioned in the mold could be the alloy steel against which the low carbon steel is cast. Similarly, if a three layer plate is desired, a slab of the alloy steel which has been cleaned on both sides may be positioned at the center of a mold with casting cavities at either side into which low carbon steel may be poured to form a three layer composite ingot; or two slabs of the low carbon steel could be placed at the sides of the mold leaving a casting cavity between them into which the alloy steel is cast to form a three layer composite ingot. The three layer composite ingot may be rolled into three layer composite plate in the conventional manner, as those skilled in the art will readily understand. Instead of casting one of the metals against a preformed slab of the other in the aforesaid manner, the composite plates may be fabricated by welding plates of the desired composition together. A well known method that may be used comprises placing the plates to be welded in superimposed relation with the juxtaposed faces of the plates suitably cleaned and prepared for welding, heating the superimposed plates to welding temperatures and then passing the heated plates between rolls to effect intimate contact between the juxtaposed faces of the plates whereby welding takes place over the entire contacting areas of the plates and a composite plate is produced. The fact that steels of essentially similar working characteristics can be employed and chromium need not be present avoids numerous troubles which have been involved in the production of previously known duplex materials. The foregoing methods of producing the composite pipes or plates to be used in making pipes embodying the present invention are merely illustrative and are not to be construed as the only available methods. Any method whereby composite pipes of the foregoing kind may be produced may be employed to manufacture the composite pipes to be used in the construction of pipe lines embodying the present invention, as those skilled in the art will readily understand.

It will be seen that a pipe line constructed in accordance with the present invention has a number of important practical and commercial advantages. The composite pipes can be made of low alloy steels which are easily bonded and welded together and readily worked to shape. The layers are of appreciable thickness so that there is no danger of peeling or rupture of a coating and each layer contributes structurally to the strength of the pipe. Even with inexpensive low alloy steels, highly satisfactory resistance to localized corrosion is obtained.

It should be noted that in this description and in certain of the claims, the terms "low alloy ferrous metal," "low alloy iron," and "low alloy steel" are used not only to designate those ferrous metals, including irons and steels, having an alloy content effective to alter the electrochemical potential, but also include plain cast irons and carbon steels.

The present invention is a species of the generic invention disclosed and claimed in applicant's copending application, Serial No. 207,485, filed May 12, 1938, and which matured on April 8, 1941, as Patent No. 2,237,321.

Although the invention has been described in considerable detail with respect to pipe lines as a preferred embodiment, other structures, objects, etc., which are exposed to similar conditions are to be considered equivalents and to come within the scope of the invention as described in the specification and defined by the appended claims.

I claim:

1. As an article of manufacture, a composite soil pipe resistant to penetration by pit corrosion when in the soil composed of at least two and not more than three structural iron base metal layers, the exposed layer being less noble than the under layer by a potential difference of about 0.07 to 0.2 volt, said layers being in good electrical contact over substantially their entire contacting surfaces, said exposed layer being of substantially greater thickness than a mere coating and both layers contributing structurally and appreciably to the strength of the pipe.

2. As an article of manufacture, a composite soil pipe resistant to penetration by pit corrosion when in the soil and being constructed of two structural layers of steel, the under layer containing alloying material in sufficient amount to render it more noble than the outer layer by a

potential difference of about 0.07 to 0.2 volt, both layers contributing structurally and appreciably to the strength of the pipe.

3. As an article of manufacture, a composite soil pipe resistant to perforation by pit corrosion when in the soil and when containing a corrosive fluid, said pipe being made of three structural layers of steel, the intermediate layer containing alloying material in sufficient amount to render said intermediate layer more noble than the outside layers by a potential difference of about 0.07 to 0.2 volt and all layers contributing structurally and appreciably to the strength of the pipe.

4. As an article of manufacture, a composite soil pipe resistant to penetration by pit corrosion when in the soil having an outer structural layer of plain carbon steel exposed to the soil and an under structural layer of steel bonded thereto containing up to about 5% nickel to render the under layer more noble than the outer layer by a potential difference of about 0.07 to 0.2 volt, each layer being of substantial thickness and contributing structurally and appreciably to the strength of the pipe.

ANDREW WESLEY.

Nov. 25, 1952 W. W. HARRIS ET AL 2,619,455

GALVANIC ANODE

Filed Sept. 2, 1950

Fig. 1.

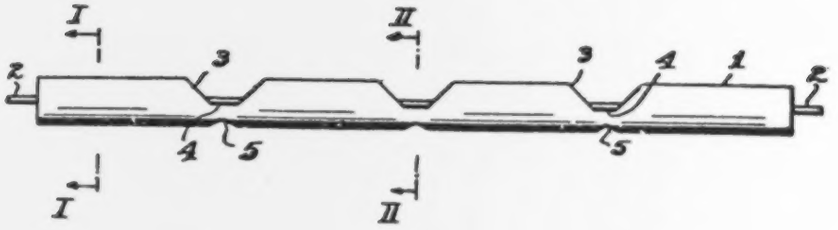


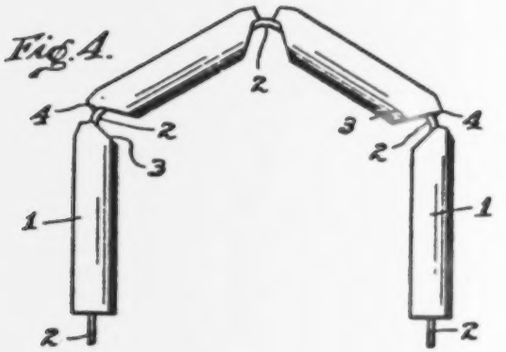
Fig. 2.



Fig. 3.



Fig. 4.



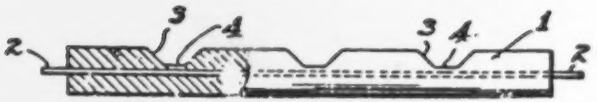


Fig. 5.

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UNITED STATES PATENT OFFICE

2,619,455

GALVANIC ANODE

Wesley W. Harris, Cleveland, and Wiser Brown, South Euclid, Ohio, assignors to Aluminum Company of America, Pittsburgh, Pa., a corporation of Pennsylvania

Application September 2, 1950, Serial No. 183,824

13 Claims. (Cl. 204—197)

1

This invention relates to rod-like anodes of the type placed inside tanks, boilers and the like to protect them against corrosion. In particular, the invention is concerned with anodes having a wire core, the anodes being designed for separation into segments which remain connected solely through the core wire or its equivalent.

Although light metal rods three feet or more in length are used for cathodically protecting iron tanks, it is not always convenient or possible to install such rods in previously erected tanks or receptacles because of the small clearance between the tank and adjacent structure or equipment. To overcome this difficulty it has been proposed that the anodes be made in sections and connected to each other by means of a wire, cable or other flexible metallic electrical conductor partially embedded in the anodes. The anode sections may be separately cast around short pieces of wire long enough to extend beyond the ends of the cast body and the sections then connected by forming linked eyes with the ends of the protruding wires or the connection may be made in any other manner that will provide an articulated joint between the sections. Another method of connecting the sections is to cast them separately on a single long piece of wire. Still another method would be to machine a solid rod having a wire core and expose short lengths of the wire between the sections. In any case the series of connected sections can be sharply bent at the joints, if necessary, when being inserted in a tank. On the other hand, satisfactory connected sections cannot be made from a solid rod having a wire core by simply breaking the rod at intervals without stretching, twisting or even breaking the wire when bending is attempted. A wire deformed in this manner would be apt to fail during subsequent service.

To cast separate anode sections as mentioned above is, of course, an expensive operation. If the sections are to be separately cast on individual wires, a large number of molds would be required for any sizable commercial operation. On the other hand, if a plurality of sections are to be placed on one wire, they may be cast successively or poured simultaneously with runners between adjacent sections. In the last named instance, however, the runners would have to be subsequently trimmed off. To machine sections from a solid rod adds a step to the fabricating schedule with attendant increase in cost of the final product. These disadvantages have led us to devise a new type of anode which can serve as a rigid member or be separated into two or

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more connected segments. The provision of such a galvanic anode is the principal object of our invention.

One embodiment of our invention is illustrated in the accompanying drawings in which:

Fig. 1 is a side elevation of an anode;

Fig. 2 is an enlarged cross section taken on line I—I of Fig. 1;

Fig. 3 is an enlarged cross section taken on line II—II of Fig. 1;

Fig. 4 is a side elevation of anode which has been separated into segments; and

Fig. 5 is a view similar to Fig. 1, partially in section, wherein the notches do not expose the core member.

The novel article we have produced comprises an anode body of rod-like proportions and flexible metallic core member such as a wire of another metal embeddied in the body and extending lengthwise thereof, and at least one transverse indentation or notch between the ends of the anode body which extends to a depth that permits ready breaking of the body and bending of the core member without substantial stretching of said member and, preferably, is at least as deep as the embedded member thus leaving a substantial amount of metal in the cross section to form a rigid body. Usually a plurality of notches will be most advantageous. An anode of this character can be employed as any other rigid anode of similar length or it can be broken or otherwise separated into segments as determined by the notches. Its particular advantage, however, lies in the ease with which it can be converted into segmental form and the wire bent and straightened without damage. Inasmuch as the anode is initially an integral body we choose to refer to the parts thereof after the anode is broken as being segments.

The transverse notch or indentation should be wide enough to allow the segments to be turned at a right angle to each other if the notch forms the inside of the angle without compressing the ends of the segments or stretching the core member. Preferably, the notch should have a base section that exposes a short length of the core member, however, this may not be necessary under all conditions and it may be advantageous not to expose the core member. Where this condition exists the notch should have a sufficient depth to permit easy breakage of the anode body through the portion having a diminished cross section and the metal between the notch and the core member should be relatively thin so that it will break away from the core or at least not

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cause the core member to stretch substantially when bent subsequent to breaking the anode body. It is preferable to taper or slope the side walls of the notch inwardly, i. e. toward each other, and to provide a substantially flat section parallel to the axis of the anode as the base of the notch and between the sloping walls. A convenient rule to follow in establishing the proportions of the notch is to make it extend about half way through the anode and to employ a flat base section the length of which is not less than half the maximum cross sectional dimension of the anode and slope the walls or sides at not more than 45° to the axis of the rod. The side walls of the notch need not be flat nor is it essential that they taper inwardly as previously mentioned, only that they be sufficiently separated at their base to permit turning the segments as far as a right angle to each other without the walls of the notch pressing against each other. The notch may have a curved surface, if desired, of either uniform or non-uniform radius. Where the surface is curved, that portion of the notch which exposes the core member or, is closest thereto, is to be considered its base.

An anode which possesses the foregoing features is illustrated in the accompanying drawings where the rod-like anode body 1 is of circular cross section. Concentrically embedded in the anode and extending beyond the ends thereof is wire 2. The notches at regular intervals have tapered sides 3 and flat sections 4, the length of the flat section being equal to the radius of the rod. To facilitate breakage of the anode at the center of the notches it may be desirable to provide small transverse grooves 5 on the opposite side of the rods. In the broken anode shown in Fig. 4, the wire 2 is seen as the connection between the segments. In Fig. 5 the wire 2 is not exposed at the base 4 of the notch, however, the notch is of a depth which permits breakage of the anode and a bending of the wire without substantial stretching thereof.

The anodes may be of any convenient length and cross section except that the length should considerably exceed the transverse dimension. A ratio of length to maximum cross sectional dimension exceeding 15 to 1 is an example of such a proportion. In cross section the anodes may be round or polygonal, the shape being a matter of choice and ease in manufacture. Because their length considerably exceeds the transverse dimension, the anodes are here referred to as being rod-like.

Anodes made of the light metals provide the most efficient cathodic protection based upon the ampere-hours produced per unit weight of metal consumed and they are therefore preferred. However, heavier metals such as zinc can be employed in the same manner and anodes of the kind described above can be made of this metal. The term light metal as used herein refers to aluminum and magnesium, and the alloys in which they predominate. Those alloys in which aluminum or magnesium constitute at least 70% of the total weight are most desirable. Among the alloying elements which improve the performance of magnesium for cathodic protection are aluminum, zinc, and manganese in amounts of 1 to 30%, 1 to 25% and 0.1 to 2%, respectively. In the case of aluminum base alloys the addition of 1 to 20% zinc is advantageous.

The anodes may be in either cast or wrought form but the most convenient method of producing them is by casting. In this way wires

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of the desired length can be easily embedded in the desired place and the notches made at the desired locations. Also, anodes of any length can be made without cutting a longer body. Wrought rods can be fabricated which have an embedded wire core. For example, an extruded rod can be produced that has a wire core. Such a product may be rolled or forged and notches made at regular intervals in known manner as by die rolling or by machining.

The embedded wires or similar members serve both to mechanically connect the separated segments and as electrical conductors from the anodes to the tank or metal body being protected. These members must, of course, have sufficient strength to hold together the separated segments of the anode and yet possess sufficient ductility to permit bending. A good metal to metal contact should exist between the member and the anode metal to insure as low resistance as possible to flow of the electric current. Generally the metal core member should have a melting point above that of the anode metal to avoid melting during the casting operation but this may be unnecessary where the anode is extruded around the member. The wire should in most cases be of a metal that is cathodically protected by the anode metal. Such metals as copper, iron, steel, stainless steel and Monel metal are suitable for the purpose but steel is usually preferred because of its cheapness. Although wires are generally most useful, larger embedded connectors such as rods may be employed providing they can be easily bent. Stranded cables or other flexible metal connectors may also be used. The size and shape of the wires form no part of the instant invention. It is preferable that the wire be concentrically positioned in the anode but this is not essential providing it is exposed over a short distance and the anode can be broken or separated without undue strain upon the wire. The wires, rods, stranded cables, or their equivalents are herein referred to as flexible metallic core members. In some cases it may be desirable to employ two or more core members providing they are in the same plane and therefore can be bent alike in the same bending operation.

This application is a continuation-in-part of co-pending application Serial No. 23,546, filed April 27, 1948, now abandoned.

Having thus described our invention, we claim:

1. An anode of rod-like proportions comprising a rigid anode body and a flexible metallic core member cathodic to the anode body embedded lengthwise in said body, said anode body having at least one transverse notch between its ends exposing a portion of said core member.

2. An anode of rod-like proportions comprising a rigid anode body and a flexible metallic core member cathodic to the anode body embedded lengthwise in said body, said anode body having at least one transverse notch between its ends the base of which exposes a portion of said core member and is of a length not less than half the maximum cross sectional dimension of the anode body.

3. An anode of rod-like proportions comprising a rigid anode body and a flexible metallic core member cathodic to the anode body embedded lengthwise in said body, said anode body having at least one transverse notch between its ends the base of which exposes a portion of said core member and is substantially flat and parallel to the axis of the anode, said base having a length

not less than half the maximum cross sectional dimension of said anode body.

4. An anode of rod-like proportions comprising a rigid anode body of circular cross section and a flexible metallic core member cathodic to the anode body concentrically embedded lengthwise in said body, said anode body having at least one transverse notch between its ends the base of which exposes a portion of said core member and is of a length not less than half the maximum diameter of the anode body.

5. An anode of rod-like proportions comprising a rigid anode body of circular cross section and a flexible metallic core member cathodic to the anode body embedded lengthwise in said body, said anode having at least one transverse notch between its ends the base of which exposes a portion of said core member, is substantially flat and parallel to the axis of said anode body, and of a length not less than half the maximum diameter of said anode body, the side walls of said notch being flat and sloping inwardly toward the base, said sloping side walls being at an angle of not more than 45° to the axis of the anode body.

6. An anode of rod-like proportions comprising a rigid anode body having a ratio of length to maximum cross sectional dimension exceeding 15 to 1 and a flexible metallic core member cathodic to the anode body concentrically embedded lengthwise in said body, said anode body having at least one transverse notch between its ends the base of which exposes a portion of said core member and is of a length not less than half the maximum cross sectional dimension of said anode body.

7. An anode of rod-like proportions comprising a rigid anode body and a flexible metallic core member cathodic to the anode body embedded lengthwise in said body, said anode body having at least one transverse notch between its ends, the base of which exposes a portion of said core member, and a transverse groove on the side of said body opposite said notch.

8. An anode of rod-like proportions comprising a rigid light metal anode body and a flexible metallic core member cathodic to the anode body embedded lengthwise in said body, said anode body having at least one transverse notch between its ends the base of which exposes a portion of said core member.

9. An anode of rod-like proportions comprising a rigid anode body of magnesium base alloy having a circular cross section, a flexible metallic core member cathodic to said magnesium base alloy concentrically embedded lengthwise in said

body, said anode body having at least one transverse notch between its ends, the base of which exposes a portion of said core member and is of a length not less than half the maximum diameter of said anode body.

10. An anode of rod-like proportions comprising a rigid light metal anode and a flexible steel wire core member embedded lengthwise in said body, said anode body having at least one transverse notch between its ends the base of which exposes a portion of said core member.

11. An anode of rod-like proportions comprising a rigid cast magnesium alloy anode body of circular cross section and a flexible steel wire core member concentrically embedded lengthwise in said body and extending beyond the ends thereof, said anode body having at least one transverse notch between its ends the base of which exposes a portion of said core member and is of a length not less than half the maximum diameter of said anode body.

12. An anode of rod-like proportions comprising a rigid anode body and a flexible metallic core member cathodic to the anode body embedded lengthwise in said body, said anode body having at least one transverse notch between its ends of a substantial depth, the base of said notch being in close proximity to the core member, the thickness of the metal between said notch base and the core member being such that the metal is broken away from said core member when the anode is broken and the core member is bent in the direction of the notch.

13. An anode of rod-like proportions comprising a rigid anode body of magnesium base alloy and a flexible steel wire core member embedded lengthwise in said body, said anode body having at least one transverse notch between its ends of a substantial depth, the base of said notch being in close proximity to the steel wire core member, the thickness of the metal between said notch base and the steel wire being such that the metal is broken away from said wire when the anode is broken and the wire is bent in the direction of the notch.

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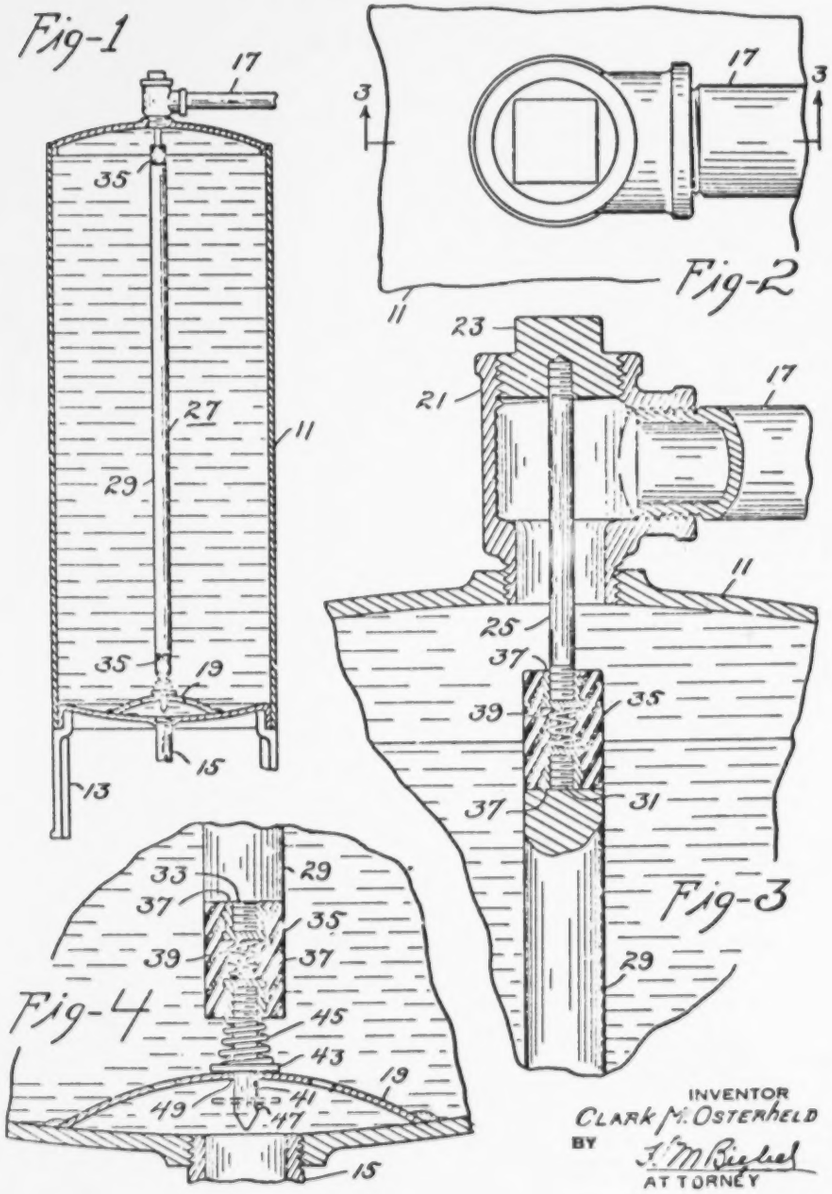
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Oct. 20, 1953 C. M. OSTERHELD 2,656,314

CORROSION PREVENTING MEANS

Filed May 28, 1947 2 Sheets-Sheet 1



Oct. 20, 1953 C. M. OSTERHELD 2,656,314

CORROSION PREVENTING MEANS

Filed May 28, 1947 2 Sheets-Sheet 2

Fig-5

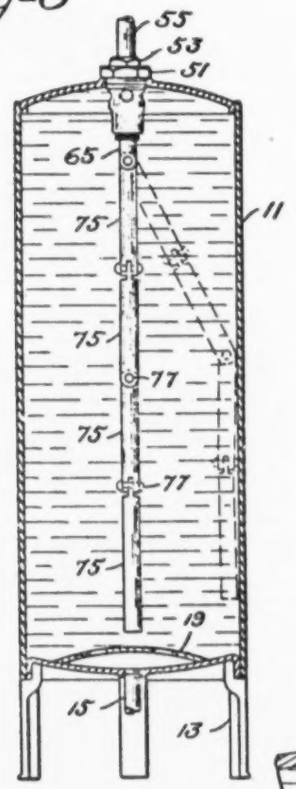
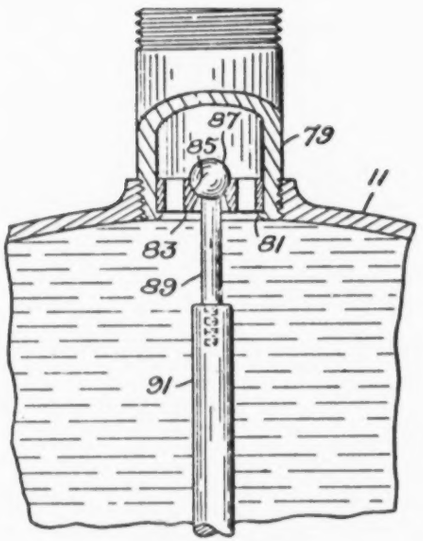


Fig-6



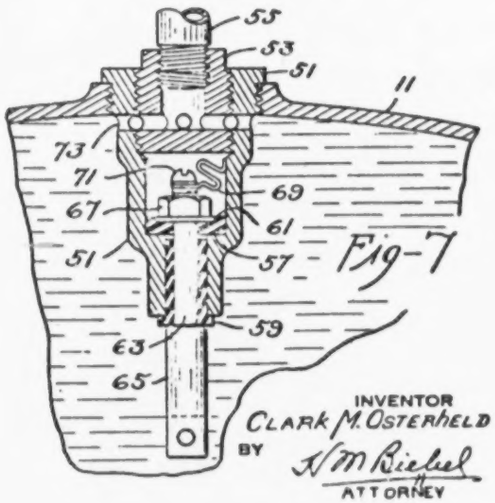


Fig-7

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2,656,314

CORROSION PREVENTING MEANS

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Application May 28, 1947, Serial No. 750,900

14 Claims. (Cl. 204—197)

1

My invention relates to ferrous metal storage tanks, and more particularly to hot water storage tanks such as used for domestic purposes. As is well known, hot water is frequently withdrawn from such tanks and replaced by incoming cold water.

One of the objects of my invention is to provide a relatively simple but highly efficient means for preventing corrosion of the inside surface of a hot water tank when the same is filled over extended periods with water.

Another object of my invention is to provide a corrosion-preventing means and method that shall be simple and easy to install, that shall continue in operating condition over extended periods of time and use of which shall result in reducing the initial cost of the tank itself.

Another object of the invention is to provide as means in a metallic hot water tank a sacrificial anode from which, without the necessity of an externally supplied voltage, a protective current will flow through the water itself to all areas of the tank, the anode sacrificing itself to corrosion and preventing corrosion of the tank. Further, it is proposed to provide a protective anode of a material which is practically useful with respect to operating efficiency, operating life, and cost of initial installation and replacement.

Another object of my invention is to provide relatively simple means for preventing corrosion of the inside surface of a ferrous metal hot water tank that shall embody means to control the rate of dissociation of the corrosion-preventing member. More particularly, it is proposed to provide control means that, while prolonging the operative life of the corrosion-preventing member, will ensure full protection of the tank. In conjunction with a protective sacrificial anode, in the electrical connection between the anode and the tank, it is proposed to incorporate an electrical resistance element of suitable ohmage to prolong the life of the anode but not so large as to reduce the protective current flow to the tank below the minimum required to ensure complete tank protection.

A further object of my invention is to provide uniformity of protection against corrosion throughout the entire surface area of the tank.

A further object of the invention is to provide corrosion protection for a metallic hot water tank with a sacrificial anode which will operate satisfactorily under varying conditions which affect the amount of the protective current flow between the anode and the tank, and to provide means for minimizing the effect of such conditions. In particular, it is proposed to minimize variations in protective current flow on the changes in the resistance or conductivity of the water with changes in temperature, which may

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be considerable in hot water tanks, by providing a resistance element having an ohmage which is constant, or substantially so, under temperature changes, and which resistance element will materially lessen fluctuations in the protective current with changes in the water resistance.

Other objects of my invention will either be apparent from a description of several forms of devices embodying my invention or will be pointed out in the course of such description and particularly in the appended claims.

It has long been known that water used for ordinary heating purposes or for domestic or other similar uses contains different substances and that it may either be slightly acid (trace of hydrochloric acid), alkali-containing (such as sodium hydroxide) or saline (such as magnesium chloride). When such water is contained in a tank it will, of course, under certain conditions, constitute an electrolyte and may have a deleterious action and effect upon the inside surface of the tank, particularly so if the tank consists of a ferrous metal, which in itself may contain impurities of the kind usually found in iron. Various methods of protection against such action have been proposed.

The most common prior method of protecting ferrous metal water tanks against deterioration due to water conditions has been to coat the inside surface of the tank with zinc. However, such method is far from reliable for reasons hereafter pointed out, and is expensive as well.

I have found that by the use of my invention, it is unnecessary to provide a zinc coating on the inside surface of a tank adapted to contain domestic water, that is, to be filled over extended periods of time, the water itself, of course being changed as withdrawals from the tank occur in ordinary use. In such case the tank should be made of relatively pure iron, now available on the market. However, the invention is operative in a zinc lined tank, and with advantages over the use of either such protective coating or the invention alone as hereafter explained.

In practicing my invention I provide, irrespective of whether the inside surface of the tank is zinc coated or not, a corrosion-preventing member comprising a rod or other block of a material anodic relative to the ferrous metal of the tank, this anodic member having, preferably, but not necessarily, a shape or outline symmetrical to that of the tank itself, the anodic member being supported in the tank in a predetermined position relatively to the inside walls thereof by suspending or supporting means or both. An electrical connection is established between the anodic member and the tank, preferably at one or both ends, through an interposed current-reducing ohmic resistance member or members

suitably encased in a waterproof housing for protection against water in the tank. Conveniently, such a member may be housed in the supporting means by which the anodic member is secured to the tank. I use the term "anodic" to indicate that the material thereof, either a metal or alloy, will be that pole or terminal from which an electric current flows through the water electrolyte to the other pole or terminal of the circuit, which other pole or terminal is the cathode and in this case is the tank itself. In other words, the anodic member is the one which is dissolved or attacked by the electric current caused by the electrolyte engaging two dissimilar electric conducting materials.

The sacrificial anodic member comprises magnesium. There are numerous materials in the electromotive series which are anodic to iron. However, some of such materials are too active in water and would be consumed so rapidly as to be impractical for present purposes. Other such materials, including zinc, have a low operating efficiency and the protective current flow which they are capable of producing under many conditions would be below the minimum to insure complete protection against corrosion, and this would be particularly true where an external resistance is to be employed in the circuit between the sacrificial anode and the cathodic metal surface to be protected. Such operating inefficiency in part results from a low potential difference between such metals and iron but also results from the tendency of the metals to polarize in an electrolyte solution. Such polarization materially reduces the effective protective current. Zinc is considered unsatisfactory for this reason. Again, various metals, particularly when containing impurities, are subject to local battery action, one type of polarization, between different surface areas thereof in an electrolyte solution which causes them to be consumed too rapidly to make them useful for a sacrificial anode and the local current flow serves no useful function in the protection of the tank. While magnesium is subject to a certain amount of local battery action which hastens its corrosion and useful life, it undergoes very little polarization of other types and is well adapted to ensure adequate current flow to protect the tank when employed with as well as without a substantial resistance in conjunction therewith.

In the drawings:

Figure 1 is a view in vertical section through a domestic hot water tank of cylindrical shape having mounted herein a device embodying my invention;

Figure 2 is a fragmentary top plan view thereof showing certain parts only;

Figure 3 is a fragmentary view taken on the line 3—3 of Fig. 2;

Figure 4 is a fragmentary view of the bottom portion of an element embodying my invention;

Figure 5 is a view in vertical section taken through a domestic hot water tank and including in modified form an anodic element embodying my invention;

Figure 6 is a fragmentary view showing only the top end of a tank end of a still further modification of anodic invention; and

Figure 7 is a fragmentary view showing the upper part of the tank and of the support for the anodic elements shown in Figure 5 of the drawings.

I have illustrated a domestic hot water tank 11 as of elongated shape and of cylindrical transverse section and provided with supporting means 13 and a cold water inlet 15 at the bottom of the tank, as well as a hot water outlet pipe 17, the latter being connected to the tank at the upper end thereof. The inner end of cold water inlet pipe 15 is covered by a perforate baffle member 19 of metal which I have shown, for purposes of illustration, as being of circular shape and of arcuate section.

The hot water outlet pipe 17 may be threaded into a fitting 21 of T-shape, one end of which is screwed into an opening in the top of the tank while the upper end thereof is closed by a plug 23, which plug is adapted to receive a metallic suspending rod 25 and the anodic element 27 now to be described.

This element 27 includes more particularly a block, preferably in the form of a magnesium rod 29. Both ends of this rod, which is shown as somewhat shorter than the axial or longitudinal dimension of the tank itself, is made of reduced size and screw threaded, as shown at 31 and 33 in Figs. 3 and 4 of the drawings. I do not desire to be limited to a rod form of block, but I have obtained very good results in the use of such kind of members in domestic hot water tanks made of ferrous metal.

I provide members 35 of electric-insulating material, which may consist of a molded composition which will withstand the acid, alkaline or saline waters to which they may be subjected when in use in a tank, or they may be made of ceramic or vitreous material. Each member is provided with a tubular insert or thimble 37 which is provided with internal screw threads and which are electrically connected to the respective ends of a sealed-in resistor member 39, which may be made of Nichrome or any other suitable material adapted for the purpose and which has a predetermined ohmic resistance as hereafter more fully explained.

The suspending rod 25, as was hereinbefore noted, has screw threaded engagement at its upper end (in a vertically-extending hot water tank) with the plug 23, while its lower end fits into and has screw threaded engagement with one of the thimbles 37, while the lower thimble 37 in the upper member 35 is engaged by the reduced end portion 31 of the rod 29.

I provide a similar member 35 at the lower end of the rod, one thimble or tubular insert 37 of which has screw threaded engagement with reduced end portion 33 of rod 29, while the lower thimble 37 is engaged by the upper end of a short pin 41 which has mounted thereon a washer 43 and a coil spring 45 extending between the tubular insert 37 and the lower end of the member 35 and the washer 43, the washer being normally biased along the pin or rod 41 into engagement with a stop pin 47 fixed near the lower end of rod 41. When the anodic element structure 27 is in its normal operative position in a hot water tank of the kind shown in Fig. 1, the rod 41 extends through an opening 49 in baffle 19, this opening 49 being in substantial alignment with the cold water inlet pipe 15. It will be noted that the anti-corrosion element 27 will therefore be substantially coaxial with the cylindrical tank 11 for a purpose to be hereinafter referred to. While I have shown a single corrosion-preventing element only, I do not desire to be limited thereto and may use a plurality of such elements peripherally spaced from each other and on a circle of predetermined but relatively small diameter.

In case the tank is filled with water which, due

to the presence therein of minerals and other matter, is not pure but is either acid, alkali or saline, an electrolytic action will occur between the magnesium of the rod or rods within the tank and the inside surface of the ferrous metal tank, the amount of such electrolytic action being, of course, dependent upon the degree of acidity or alkalinity or salinity of the water and, to some extent, also dependent upon the exposed surface area engaged by the water.

It will be understood that since the rod element 29 is electro-positive with respect to the iron of the tank, galvanic current will flow through the water electrolyte from the rod to the tank and thence from the tank back to rod 29 through the interposed resistor elements 39. The rod will gradually be consumed as positive metallic ions thereof go into solution while a relatively large galvanic pressure is established which prevents the flow of ions from the inner surfaces of the negative iron of the tank into solution. Thus the tank is effectively protected from corrosion as long as the galvanic circuit is maintained until the rod is consumed.

The current flow as here controlled is relatively small, preferably of the order of 5 to 10 milliamperes, so that corrosion of the magnesium rod is not rapid. The flow of current and the rate of dissociation and life of the rod will depend, although not entirely, upon value of the resistor elements, and will vary with the character of the water and the internal resistance of the water between the rod and the tank wall. In localities where the water has a high mineral content, the internal resistance will be lower, and the current flow and rate of dissociation of the rod higher, than in localities where the water has a relatively low mineral content. Nevertheless, it has been found in practice that the rod would require replacement in many instances within a year or so unless conservation methods as here proposed are taken to control the current flow. Thus, if a direct connection is made between the anode rod 29 and the tank, instead of making the connection through the interposed electrical resistor 39, the flow of current would vary only with the internal resistance of the water solution. It should be kept in mind, of course, that the internal resistance of the water is the total resistance of the water path between the anode and the tank. Since it is practically impossible to so arrange the anode, at least when in the form of a rod, so that it will be uniformly spaced from all side and end surfaces of the tank, even though arranged in axial position in a cylindrical tank as in Fig. 1, the internal resistance, and consequently the amount of the protective current flow, will vary between the anode and the different areas of the tank surface. Since it is important that at least the minimum current necessary for protection should flow to all surface areas of the tank, the internal resistance of the water is considered to be the maximum internal resistance of the longest water path between the anode and the tank.

It has been found that an extremely small galvanic current flow in the circuit, plus a relatively high potential difference between the anodic rod and the tank, provide the best conditions for uniform protection of all areas of the tank and prolong the useful life of the anodic rod. The resistor elements 39 serve to obtain these conditions by providing an appreciable resistance in the external portion of the galvanic circuit in addition to the internal resistance of the water electrolyte. The value of the resistor should be 5 ohms, or better, 10 ohms, as a practical minimum, and normally will be considerably higher as hereafter explained.

The reason that the present protective means is more effective and reliable than a zinc coating on the interior tank wall can be readily understood. Extended tests on my part have shown that this zinc may contain small quantities of impurities such as tin, copper, aluminum, carbon or sulphur, either any one of these impurities or a plurality of such impurities. These minute particles of impurities may be found in the zinc coating at separated spots. In case the zinc coating contains any one or all of the above mentioned impurities and if these are located at or near the perforations in the zinc coating, the iron may be attacked because of electrolytic action between the impurities and the iron will be corroded or dissociated, and the same comment may be made as to similar conditions of dissociation of the iron occurring in case the iron itself contains impurities usually found mixed therewith.

There is always the further danger in a coated tank that the protective zinc coating is not perfect and contains perforations in the form of minute openings as the result of any one or several operating difficulties and conditions experienced in the zinc coating of the inside of a closed ferrous metal water tank. Where the coating is defective the zinc surrounding the perforation will go into solution, since it is anodic to iron, that is, zinc ions will pass into solution and flow to the exposed iron, thereby preventing the iron ions from going into solution. This causes dissociation of the zinc with attendant increase in the size of the opening in the zinc. As long as the distance from the iron to the edge of the protecting zinc is small, the zinc will protect the iron uncovered by the perforation and no corrosion of the iron will occur, but when the zinc has been eaten back a little further, the current flow is from the zinc to the nearby area of the iron, and the more distant uncovered areas of the iron are no longer protected and corrosion begins at the unprotected part. The galvanic couple comprising the zinc and the iron being so connected cannot set up an appreciable electromotive force, so that the iron is protected only closely adjacent to the edge of the zinc coating.

The use of a zinc lining on the tank as the sole corrosion preventing means for the ferrous tank metal is subject to the objections previously mentioned. When employed in conjunction with the magnesium sacrificial anode not only does the zinc coating not adversely affect the tank protectioning function of the anode and function itself for the same purpose but the coating and anode each improve the functioning of the other. Magnesium is anodic to zinc as well as to iron so that the current flow from the anode protects the zinc lining against corrosion, in the absence of which the tank metal will be preserved against contact with the water in the tank. Further, the presence of the zinc coating will prolong the life expectancy of the anode since the potential difference between magnesium and zinc is less than between magnesium and iron so that the protective current flow will be somewhat less and the anode will be consumed more slowly.

It is desirable that hot water tanks should have many years of useful life without corrosion. It is similarly desirable that the anodic protective rod here employed to prevent corrosion should itself have as long and useful life as possible and not

require replacement in six months or a year or two. The operating life of the anode protection of the tank can be prolonged through the addition of one or more resistor elements as previously explained. Furthermore, the anode life and resistor value are interrelated and vary directly with one another. The resistor value required to provide a selected minimum life for a particular anode can, at least approximately, be readily predetermined, and conversely, it can be determined what the minimum life of anode will be when using a resistor of a particularly selected value.

The life of the anode and the value of the external resistance depend on a number of factors. The higher the total current flow from the anode, both protective current flow to the tank and the local flow under battery action between different areas of the anode, the more rapidly will the anode go into solution and the shorter its life. Hence, it is desirable to use as high a value external resistor as practical to ensure not less than the minimum protective current flow to the tank necessary for complete protection against corrosion. The effect of battery action is quite appreciable and causes the anode to be consumed in less than half the life expectancy of the anode if determined theoretically only on the basis of the current flow to the tank. While the shortening of the life of the anode by battery action is not definitely known, it is here assumed, to be on the safe side, that battery action reduces the life of the anode by 65% or, to state the matter conversely, that the anode will be consumed in 35% of its theoretical life expectancy.

The protective current is determined by five factors. One is the potential difference between the anode and iron and for magnesium this is taken as 1.43 volts. Another factor is the specific conductance of the water which will vary considerably with waters of different hardness and softness. The protective current will further be determined by the internal resistance of the water path between the anode and the surface of the tank, and this in turn depends upon the specific conductance of the water and the difference in dimensions of the tank and the anode and upon the temperature. The resistance of solutions of electrolytes declines at about the rate of 1% for 1° F increase in temperature. The other factor is the value of the external resistor which is in series with the internal resistance of the tank, and the sum of which is the total resistance. The adverse effect of polarization of the magnesium anode is ignored because it would be substantially negligible as long as the pH is below 12.5, which would be true for any known domestic water supply.

The unit consumption rate of the anode metal in grams per ampere hour being expressable both in terms of weight and time

$$\frac{W}{T}$$

and in terms of current and anode metal electrochemical equivalent

$$\frac{E}{R}\cdot Eq.$$

the formula derived from the resulting equation for approximately determining resistance and time, one from the other, is as follows:

$$(R_1R_2)=\frac{E\cdot Eq}{W}\cdot T \text{ or } T=\frac{W}{E\cdot Eq}\cdot(R_1R_2)$$

where:

R_1=value of the internal water resistance

R_2=value of resistance in ohms of the resistor

E=the potential difference in volts between the anodic metal and tank metal (1.43)

Eq=electrochemical equivalent of magnesium in grams per ampere hour (.447)

T=years of anode life, expressed in hours (8760 hours per year)

W=weight of anode in grams, or in pounds times 453.59.

The value of the internal resistance R_1 for any given operating temperature can be determined approximately for any given water from the tank and anode dimensions and the specific conductance of the water for average tank. Assuming a tank 39" long and 15.75 inside diameter and a co-axial magnesium anodic rod 1.575" in diameter, the internal resistance of the tank will run roughly from 112 ohms to 2 ohms at 65° F. for waters varying in hardness from 20 p. p. m. to 1000 p. p. m. and varying in specific conductance between 0.33×10^{-4} to 16.5×10^{-4}. If the temperature is 167° F. the internal resistance will be 37% of its value at 65° F.

In the formula above, T represents the theoretical life expectancy of the magnesium anode in the absence of battery action. Since over 50% of the consumption of the anode is due to local battery action the value found for T must be reduced by at least that amount. To ensure against over-calculation, it is best to assume that the actual life expectancy of the anode is about 35% of T.

The value of the external resistance R_2 may be as low as 5 ohms, or preferably 10 ohms as a practical minimum, but unless the water resistance R_1 is relatively high, the rate of consumption at such value would be far greater than necessary to ensure minimum protective current. I normally prefer to employ a resistor having a value ranging from 100 to 200 ohms, say one of 150 ohms, for general usage as this range is sufficient to ensure adequate potential difference and relatively long tank protection without replacement of the anode, and at the same time provides a substantial margin of safety to ensure an adequate current flow for complete tank protection, under widely different conditions of water resistance and taking into account the average temperature of the water over a yearly period. While the effective water resistance increases with tank size, because of greater distance between the anode and tank wall, as well as with the purity of the water so that a given anode employed with a resistor of predetermined value will have a longer life the larger the tank, the difference in diameter of the more commonly used sizes of tanks for domestic water, at least those used in the household, is not sufficiently great to materially change the water resistance. Thus it is possible to employ a standardized resistor in the range above noted for the usual domestic hot water tank of 50 gallons and larger tanks up to a capacity of at least 150 gallons or 200 gallons. In the case of extremely small tanks it would be desirable to increase the resistance value, and in the case of abnormally large tanks to use a lower resistance value in order to obtain a similar predetermined operating life for the anode. In hot water tanks under average conditions a magnesium anode of two pounds, or thereabouts, will have an actual life expectancy as high as 15 years or more. Even where such

an anode is used in the absence of an external resistor it may have a useful life of several years or more under favorable water conditions.

Where the tank is provided with a protective zinc lining such lining is cathodic relative to the magnesium anode while being anodic relative to the ferrous tank metal and in the absence of perforations in the lining the flow of current between the anode and coating will be somewhat less, with a Mg-Zn potential difference of 1.11, than between the anode and an uncoated ferrous tank wall with a Mg-Fe potential difference of 1.43. Accordingly, in the preceding formula E may be taken as the potential difference, 1.11, between the anode and zinc coating instead of between the anode and iron wall for a zinc lined tank.

For reasons of initial and replacement cost it is undesirable to employ protective anodes of substantial diameter, although the thicker the anode the greater the amount of material available therein for consumption, and the longer its useful life. I ordinarily employ an anode of between one-half inch and two inches in diameter, most commonly one of three-quarters of an inch. To insure full protection of the bottom of the tank the length of the anode should be such that the distance between the lower end of the anode and tank bottom is no greater than the radial distance between the anode and the tank. The length will be determined by the length of the tank. It will be apparent for reasons already explained that by using a current reducing resistor in conjunction with the anode a small size anode will have an operating life as long, or even longer, than an anode of greater size connected to the tank in the absence of a resistor under equivalent conditions. In other words, the resistor controls both the size and life of the anode.

Referring now to Figs. 5 and 7 of the drawings, I have there illustrated a modification embodying my invention which includes a somewhat different form of anodic element suspended in a cylindrical tank at its top end only.

The cover of the tank 11 is provided with a tubular bushing 51, the upper end of which is adapted to have screw threaded engagement in an opening in the cover of the tank 11 and which upper end is adapted to receive a nut 53 having an opening into which a hot water outlet pipe 55 may be screwed. The lower end portion of bushing 51 is provided with a flat internal shoulder 57, and the lower end of the bushing may receive a tubular spacer 59 of electric-insulating material. A flat washer 61, of electric-insulating material, is adapted to rest upon the shoulder 57 and the upper end 63 of a short anodic rod 65 of magnesium is adapted to fit in the elongated washer or bushing 59 in a fluid-tight manner and to be held therein by a nut 67, in the manner shown more particularly in Fig. 7 of the drawings.

I provide a resistor member 69 of any desired type, such as a small wire of suitable resistor material, one end of which may be held by a short machine screw 71 against the upper end of portion 63, while the other end of the resistor may be electrically connected with the bushing 51 by any suitable means such as soldering or brazing. The bushing 51 is provided with a plurality of laterally-extending openings 73 therein to permit of the outflow of hot water into and through outlet pipe 55.

I may use in connection with the upper end member 68, a plurality of pivotally connected portions 79 in the shape of magnesium rods having tongue and slot connections with each other through a pin 77. As shown in the broken lines in Fig. 5 of the drawings, in case the tank is laid on its side during shipment or at any other time, the pivotally connected sections 75 will not be subjected to an undue strain caused by the unsupported end thereof, since at least some of these sections may rest upon the tank wall itself when the tank is in a horizontal position.

Referring now to Fig. 6 of the drawings, I have there illustrated a still further modification of a corrosion-preventing element in which a short pipe section 79 may be screwed into the cover of tank 19, the upper end of section 79 being screw threaded to receive a pipe fitting, while the lower end thereof may have an inner shoulder member 81 upon which a perforated metal bushing 83 is adapted to rest. The bushing 83 is provided with a central spherical seat 85 on which the upper enlarged spherical end 87 of a suspending and supporting rod 89 is adapted to rest. The lower end of rod 89 has screw threaded engagement with the upper end of an anodic rod 91 of magnesium.

It is evident that the rod 91 will swing on its spherical seat and thereby reduce the stress on the rod in case the tank is tilted from its normal vertical position during assembly, shipment or installation.

The device embodying my invention thus provides relatively simple, inexpensive, easily installed and highly effective means for its intended purpose to not only reduce but substantially entirely prevent dissociation and corrosion of the inner surface of a ferrous metal tank, irrespective of whether the inner surface of the tank is coated with zinc or not. It further provides an anodic rod which can be, but preferably is not connected directly to the tank, but through a resistor, which is electrically insulated from the changing water in the tank. The ohmic resistance of the resistor is relatively high, so that I obtain protection by metering the current flow. A resistor which has too high an ohmic resistant reduces the current flow to a value which will not fully protect the tank because too few anodic ions are flowing to prevent the iron ions from flowing.

The anodic rod or member may be secured by a mounting to the side wall of the tank, and may extend crosswise instead of lengthwise, if desired.

I wish to point out that while I have illustrated and described a particular form of hot water tank, which is most frequently used in domestic hot water installations, my invention is not limited thereto in its broader aspects. Should the shape of the tank, and particularly of its interior surface, be quite different from that shown in the drawings, my invention preferably, but not necessarily, contemplates the use of a corrosion-preventing anodic member of a shape symmetrical to that of the inside surface of the tank but of much smaller outer surface area.

While I have illustrated and described specific embodiments of my invention, I do not desire to be limited thereto, since all modifications coming clearly within the scope of the appended claims are to be considered as being covered thereby.

This application is a continuation of my copending application, Serial No. 568,360, filed December 15, 1944, (now abandoned), which in turn

is a continuation-in-part of my copending application, Serial No. 356,622, filed September 13, 1940 (now abandoned).

I claim as my invention:

1. The combination with a ferrous metal domestic hot water tank in which cold water supplied from any of the conventionally available water sources is recurrently input and heated, and from which hot water is withdrawn at recurrent times and in varying amount according to demand, of anti-corrosion means for protecting the tank interior against corrosion comprising an elongated sacrificial magnesium metal anode of substantially smaller cross-section than the tank located within the tank to be surrounded by the tank water and relatively distant from areas of the tank to be protected, and electrically conductive means connecting the anode to the tank and adapting the anode to supply a galvanic current flow to areas of the tank metal when exposed to contact with the tank water.

2. The combination with a ferrous metal domestic hot water tank in which cold water supplied from any of the conventionally available water sources is recurrently input and heated, and from which hot water is withdrawn at recurrent times and in varying amount according to demand, of anti-corrosion means for protecting the tank interior against corrosion comprising a zinc lining on the interior of the tank, an elongated sacrificial magnesium metal anode of substantially smaller cross-section than the tank located in the tank to be surrounded by the tank water and relatively distant from the tank interior, and electrically conductive means connecting the anode to the tank and adapting the anode to supply galvanic current flow to the zinc lining and to any areas of the tank metal exposed to contact with the tank water.

3. The combination with a ferrous metal domestic hot water tank in which cold water supplied from any of the conventionally available water sources is recurrently input and heated, and from which hot water is withdrawn at recurrent times and in varying amount according to demand, of anti-corrosion means for protecting the tank interior against corrosion comprising an elongated sacrificial magnesium metal anode of substantially smaller cross-section than the tank located within the tank to be surrounded by the tank water and relatively distant from areas of the tank to be protected, and electrically conductive means including an electrical resistor element connecting the anode to the tank and adapting the anode to supply a galvanic current flow to areas of the tank metal when exposed to contact with the tank water.

4. The combination of claim 3 wherein the electrical resistor element has a value within the range of 5 ohms to 200 ohms.

5. The combination of claim 3 wherein the electrical resistor element is located in the tank and further including a water impervious housing encasing and protecting said electrical resistor element against contact by tank water.

6. The combination with a ferrous metal domestic hot water tank in which cold water supplied from any of the conventionally available water sources is recurrently input and heated, and from which hot water is withdrawn at recurrent times and in varying amount according to demand, of anti-corrosion means for protecting the tank interior against corrosion comprising a zinc lining on the interior of the tank, an elongated sacrificial magnesium metal anode of substantially smaller cross-section than the tank located in the tank to be surrounded by the tank water and relatively distant from the tank interior, and electrically conductive means including an electrical resistor connecting the anode to the tank and adapting the anode to supply galvanic current flow to the zinc lining and to any areas of the tank metal exposed to contact with the tank water.

7. The combination of claim 6 wherein the electrical resistor element has a value within the range of 5 ohms to 200 ohms.

8. The combination with a ferrous metal domestic hot water tank in which cold water supplied from any of the conventionally available water sources of ranging composition as to corrosion action is recurrently input and heated, and from which hot water is withdrawn at recurrent times and in varying amount according to demand, said tank having a wall opening, of anti-corrosion means for protecting the tank interior against corrosion comprising a metal plug constituting a removable closure for said tank wall opening and having electrically conductive connection with the tank, an elongated sacrificial magnesium metal anode of substantially smaller cross-section than the tank and adapted to pass through said tank wall opening, said anode being insulated from the plug by an electrical insulator and supported by the plug within the tank to be surrounded by the tank water and relatively distant from areas of the tank to be protected, and an electrical resistor element supported by the plug and electrically interconnecting the anode and the plug and adapting the anode to supply a galvanic current flow to areas of the tank metal when exposed to contact with the tank water.

9. The combination with a ferrous metal domestic hot water tank in which cold water supplied from any of the conventionally available water sources is recurrently input and heated, and from which hot water is withdrawn at recurrent times and in varying amount according to demand, said tank having a wall opening, of anti-corrosion means for protecting the tank interior against corrosion comprising a plug constituting a removable closure for said tank wall opening and extending into the tank, an elongated sacrificial magnesium metal anode of substantially smaller cross-section than the tank, and adapted to pass through said tank wall opening, said anode being supported by the plug within the tank to be surrounded by the tank water and relatively distant from areas of the tank to be protected, said plug being formed of water impervious material and with a hollow interior closed to exposure to the tank water, and an electrical resistor element located in the hollow interior of the plug for protection against tank water through which the anode member is electrically connected to the tank and adapting the anode to supply a galvanic current flow to areas of the tank metal when exposed to contact with the tank water.

10. An anti-corrosion unit for protecting the interior of ferrous metal domestic hot water tanks in which cold water is supplied from any conventionally available water source is recurrently input and heated, and from which water is withdrawn at recurrent times and in varying amounts according to demand, said unit being adapted for tank installation as an assembly unit and comprising a closure and supporting plug adapted to be removably mounted in a wall opening of such a tank, an elongated sacrificial magnesium metal anode of smaller cross-section than the plug supported at one end by the plug and adapted to be located within a tank to be surrounded by the tank water relatively distant from interior areas to be protected, electric insulating means insulating the anode from the plug and an electrical resistor element supported by the plug for electrically interconnecting the anode and a tank, said element having a resistance within a range of 5 ohms to 200 ohms.

11. An anti-corrosion unit for protecting the interior of upstanding cylindrical ferrous metal domestic hot water tanks in which cold water is supplied from any conventionally available water sources is recurrently input and heated, and from which water is withdrawn at recurrent times and in varying amounts according to demand, said unit comprising a metal closure and supporting plug adapted to be removably mounted in a top wall opening of such a tank, an elongated sacrificial magnesium metal anode of smaller cross-section than the plug supported at one end by the plug and adapted, when the plug is mounted in a tank, to be suspended vertically within such tank surrounded by tank water with the anode axis in parallel with the cylindrical tank wall, electric insulating means insulating the anode from the plug and an electrical resistor element supported by the plug electrically interconnecting the anode and the plug, said element having a resistance within the range of 5 ohms to 200 ohms.

12. In an anodically protected hot water heater system of the class wherein a metal hot water tank acts as a cathode and a metal anode is projected into the tank and electrically connected to the tank; the combination with the anode of a metal, water outlet fitting for supporting the anode and electrically connecting it with the tank, the fitting having an axial water passage therethrough, connecting means at the outer end of the fitting for connecting it with piping, external threads around the fitting inwardly of the connecting means, for supporting the fitting on the tank and electrically connecting the fitting and tank, the fitting having a lateral opening inwardly of the external threads, leading from the axial passage through the surface of the fitting, and means mounting the anode on the fitting, said means being below the lateral opening in the fitting and the parts of the assembly inwardly of the external threads on the fitting being no larger in overall diameter than the said threaded portion of the fitting whereby the assembly as a unit may be inserted through an opening in the end of the hot water tank and threadedly attached and electrically connected thereto.

13. An anti-corrosion unit for protecting the interior of ferrous metal domestic hot water tanks comprising a metal outlet pipe fitting and an elongated sacrificial magnesium metal anode electrically connected to and adapted to be supported by the fitting within a hot water tank, the fitting having an axial water passage leading from a first or outer end of the fitting inwardly and having a lateral water delivery opening connecting with the passage and leading through the side surface of the fitting and located inwardly of the outer end of the fitting, connecting means at the outer end of the fitting for connection of the fitting with piping, external threads around the fitting inwardly from said connecting means, for connection of the unit in a threaded wall opening of a hot water tank, attaching means connecting one end of the anode to the fitting, said attaching means being inwardly of the lateral opening in the fitting, means closing the axial passage below the lateral opening in the tubular member, and the parts of the unit inwardly of the external threads on the fitting being no larger in overall diameter than the said threaded portion of the fitting whereby the unit may be inserted through a threaded wall opening of a hot water tank, threadedly attached and electrically connected to the wall.

14. An anti-corrosion unit for protecting the interior of ferrous metal domestic hot water tanks comprising a metal outlet pipe fitting and an elongated sacrificial magnesium metal anode electrically connected to and adapted to be supported by the fitting within a hot water tank, the fitting having an axial water passage leading from a first or outer end of the fitting inwardly and having a lateral water delivery opening connecting with the passage and leading through the side surface of the fitting and located inwardly of the outer end of the fitting, connecting means at the outer end of the fitting for connection of the fitting with piping, external threads around the fitting inwardly from said connecting means, for connection of the unit in a threaded wall opening of a hot water tank, a partition across the fitting inwardly of the lateral opening, the inner end of the fitting having a socket extending thereinto, coaxial with the axial passage, the anode having an upper end located in the socket and means securing the anode tightly and rigidly in the socket, and the parts of the fitting and the anode inwardly of the external threads on the fitting being no larger than the said external threads whereby the said parts may be inserted through a threaded wall opening of a hot water tank, threadedly attached and electrically connected to the wall.

CLARK M. OSTERHELD.

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April 14, 1959 B. DOUGLAS 2,882,213

GALVANIC ANODE

Original Filed Feb. 1, 1955 4 Sheets-Sheet 1

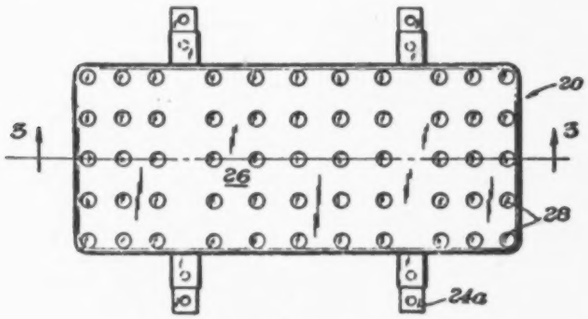


Fig. 1

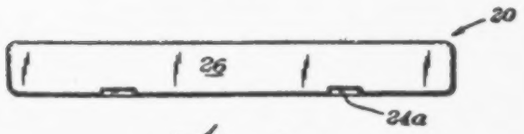


Fig. 2

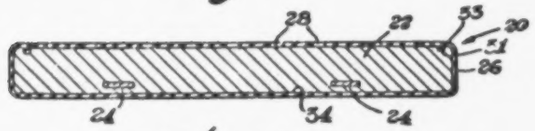


Fig. 3

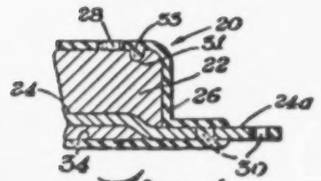


Fig. 4

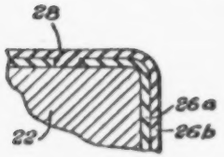


Fig. 15

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GALVANIC ANODE

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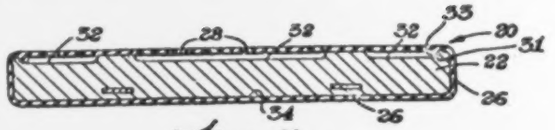


Fig. 5

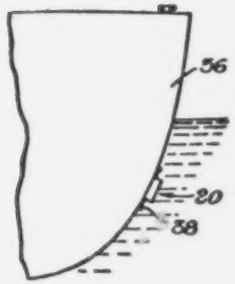


Fig. 6

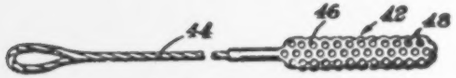


Fig. 7

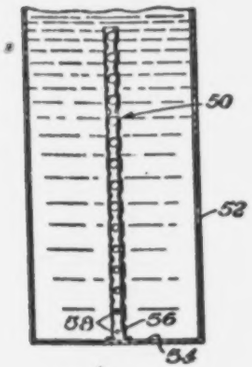


Fig. 3

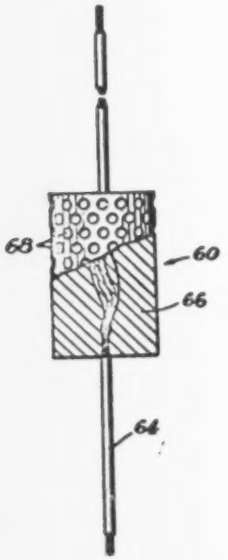


Fig. 9

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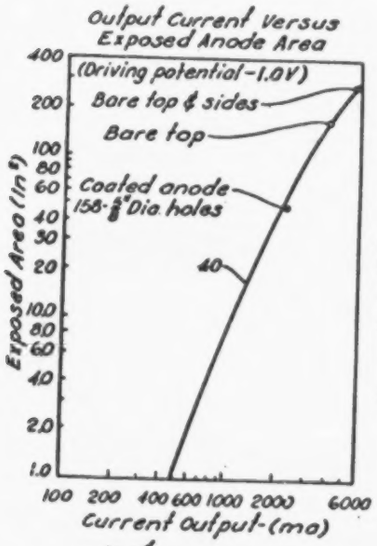


Fig. 10

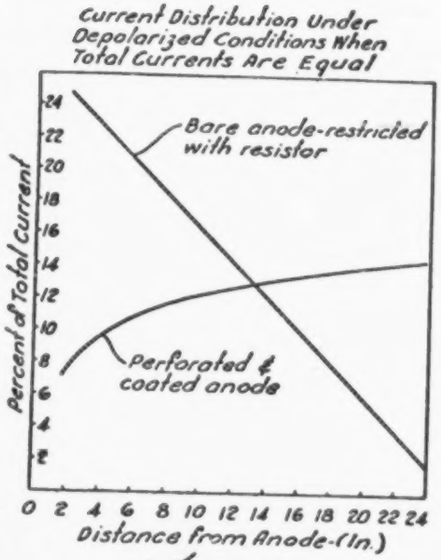


Fig. 13

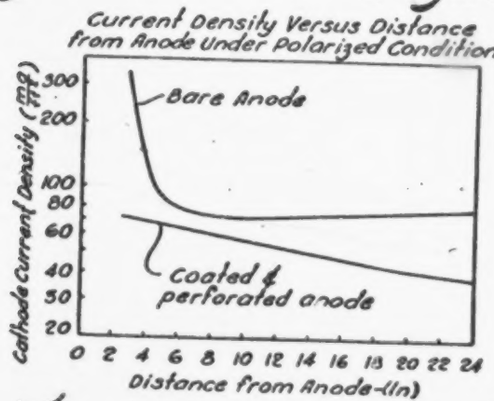


Fig. 14

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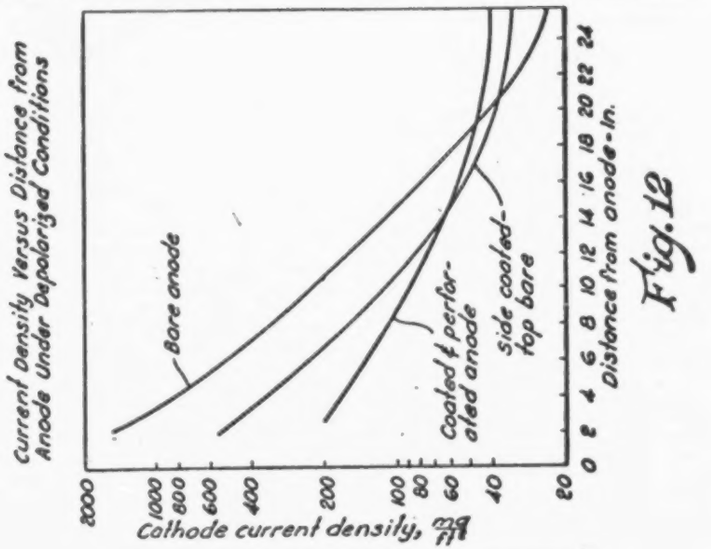


Fig. 12

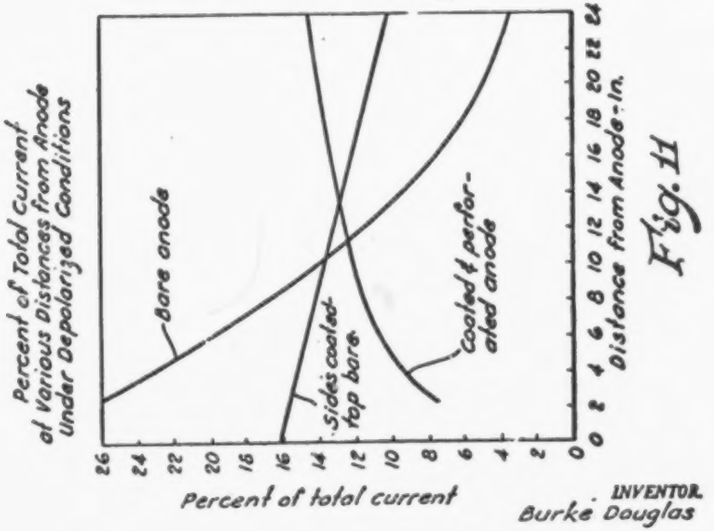


Fig. 11

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United States Patent Office

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Patented Apr. 14, 1959

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2,882,213

GALVANIC ANODE

Burke Douglas, Midland, Mich., assignor to The Dow Chemical Company, Midland, Mich., a corporation of Michigan

Original application February 1, 1955, Serial No. 485,373. Divided and this application May 6, 1957, Serial No. 657,446

6 Claims. (Cl. 204—197)

This invention relates to the cathodic protection of metals and particularly to improved consumable anodes for use in cathodic protection systems.

Cathodic protection systems are well-known in which a metal immersed in an electrolyte is protected from corrosion by means of a sacrificial or consumable anode which is immersed in the electrolyte and is electrically connected to the (cathodic) metal which is to be protected.

Sacrificial or consumable anodes comprise a metal which is anodic to the metal surface to be protected and some means, such as a metal core strap, rod or cable to attach the anode to the surface to be protected. When the anode and the surface to be protected, or cathodic surface, are in an electrolyte and are electrically connected together, the resulting flow of current between the two electrodes greatly reduces the rate of corrosion of the cathodic surface.

The cathodic protection of pipe lines, ship hulls, metal sea walls, and water tanks are examples of uses made of sacrificial anodes, such as magnesium anodes, for example. For many applications the expense of replacing anodes represents a substantial part of the cost of the protective system. Further, in the case of anodes attached to ship hulls, for example, the anodes may be replaced conveniently only at infrequent intervals, such as when the ship is in dry dock.

To avoid costly and frequent replacement of anodes, the use of large anodes which have a long useful life has become common. Large anodes, however, tend to provide larger currents than are needed for the protection of the cathodic surface and to that extent defeat their purpose of providing long-lived protection. Further, in marine service the larger anodes produce greater drag or resistance to the water passing the anodes than do smaller anodes and for this reason are undesirable for use on ships.

Resistance elements have been used in series with the electrical circuit between the anode and the cathodic surface to limit the current flow therebetween. Resistance elements give only a partial answer to the problem of extending anode life, however. Anodes are consumed as a result of chemical attack as well as by current flow, and the resistance element does not affect the rate of chemical attack. Thus, anode circuits including a resistance element operate at a lower efficiency (measured in ampere hours per pound of anode) than do anodes which are operated in systems not having series resistance elements included therein.

Anode efficiency, however, is but one criterion by which an anode is judged. Another indication of the worth of a galvanic anode is its throwing power or, stated differently, the cathodic area in which the anode provides adequate cathodic protection. The throwing power of anodes which are mounted close to the cathodic surface is quite limited since much of the current from the anode is used to protect areas of the cathodic surface which are closely adjacent to the anode. Thus,

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the close-in areas are over-protected (by excessive current) and remote areas are inadequately protected. Resistor anodes, while limiting the total current, do not change the proportional distribution of the available current.

Another difficulty encountered in connection with galvanic anodes is that the anode consumption often follows a pattern such that the magnesium anode body (for example) becomes loosened from its mounting means or core while the body weight is still a significant percentage of the anode weight when installed. For cathodic protection purposes, the anodic metal is wasted which remains after the electrical contact between the core or anode mounting means and the anode body is broken or becomes a high resistance contact.

The labor cost for mounting anodes often represents a substantial part of the cost of the cathodic protection system, since men having several basic skills, such as welders, boiler makers, and painters may be used in mounting the anodes on a ship hull, for example. An anode which requires workers having only a single skill or trade to mount would therefore result in a saving in the cost of the cathodic protection system.

Difficulties due to uneven consumption of the anode in different parts thereof have likewise been encountered when one part of an anode is closer to a cathodic surface than is another part of the anode. A cathodically protected water heater in which the magnesium anode rod is inserted from either the top or the bottom of the tank is an example of an anode use in which the anode is subject to the above difficulty.

In such water heaters (or water softeners or similar tanks), the current flow to the supporting wall of the tank, which is very close to the attached end of the anode, is often excessive. The result is that the attached end of the anode may be entirely consumed long before the remainder of the anode is depleted. This irregular depletion of the anode is undesirable because it will result in anode inefficiency.

A principal object of this invention is to provide an improved galvanic anode which has a longer useful life per unit weight of anode material.

Another object of this invention is to provide an improved galvanic anode having improved current distribution to the cathode.

A further object of this invention is to provide an improved galvanic anode structure which needs no separate insulating means to separate the anode from the cathodic surface.

Yet another object of this invention is to provide an improved galvanic anode structure having means for selectively controlling the rate of anode consumption in various parts of the anode body.

In accordance with the invention, there is provided a galvanic anode comprising a consumable body portion and core means by which electrical connection between the anode and a cathode surface may be made, the anode being enclosed in an insulating covering or casing. When the anode is ready for use, the casing is provided with a plurality of apertures in at least one surface thereof.

The invention, as well as additional objects and advantages thereof, will best be understood when the following detailed description is read in connection with the accompanying drawings, in which:

Fig. 1 is a plan view of a plastic coated anode in accordance with the invention;

Fig. 2 is a side elevational view of the anode shown in Fig. 1;

Fig. 3 is a sectional view taken along the lines 3—3 of Fig. 1;

Fig. 4 is a fragmentary sectional view, on an enlarged

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scale, showing the plastic coating extending over the mounting strap;

Fig. 5 is a sectional view taken along the lines 3—3 of Fig. 1 and showing the anode consumption pattern after partial consumption of the anode shown in Fig. 1;

Fig. 6 illustrates an anode of the type shown in Fig. 1 as mounted on the side of a ship hull;

Fig. 7 is an elevational view of a plastic coated anode in accordance with the invention which is especially adapted for use with small metal-hulled craft and which requires no underwater connection to the hull of the craft;

Fig. 8 illustrates an anode in accordance with this invention which is adapted for use in water heaters or like uses;

Fig. 9 illustrates a cable-cored coated anode in accordance with the invention;

Fig. 10 is a graph showing output current as a function of exposed anode area;

Fig. 11 is a graph showing the percent of total anode current at various distances from the anode under initial operating conditions;

Fig. 12 is a graph showing current density versus distance from anode for three types of anodes under initial operating conditions;

Fig. 13 is a graph showing the current distribution (under initial conditions) of a perforated anode in accordance with this invention and a bare anode restricted with a resistor when the total current outputs of each anode are equal;

Fig. 14 is a graph showing current density versus distance from the anode for a bare anode and a coated and perforated anode under conditions of continued operation (i.e., after 24–30 hours of operation), and

Fig. 15 is a fragmentary sectional view showing an anode having a laminated or multi-layered covering.

Referring to Figs. 1 through 4 there is shown a galvanic anode indicated generally by the numeral 20 and comprising a consumable body 22, made of magnesium, for example, and having a metal core 24 (such as steel) embedded in the magnesium and bonded thereto and extending therefrom as a mounting strap 24a. The anode is encased in a plastic cover 26 which fits closely about the anode body 22 and mounting straps 24a. The top of the plastic cover 26 contains a plurality of apertures 28 which are illustrated as being round although apertures of other configurations may be used. It should be noted that no apertures 28 appear in that part of the plastic coating which lies directly above the cores 24.

Referring particularly to Fig. 4, the plastic cover 26 extends along at least a part of the mounting straps 24a. The mounting straps 24a usually contain a plurality of bores 30 which serve two purposes. The bores 30 in the straps provide a convenient means by which the anode 20 may be bolted to a supporting structure. Also, the plastic cover 26 which extends on each side of the straps 24a flows through at least one of the bores 30, causing the plastic on opposite sides of the strap to be bonded to itself. Such bonding of the cover 26 lessens the likelihood that the plastic cover 24 will tear off the mounting straps 24a and thence tear off the anode body 22. In practice, the plastic cover 26 may entirely cover the mounting straps 24a, but may be cut back to the desired point when the anode 20 is to be mounted.

The plastic cover 26 is a dispersion resin coating of dispersion grade polyvinyl chloride resin or vinyl chloride copolymer resins plus plasticizer and stabilizer. Such anode coatings are electrically insulating and are physically tough. A coating thickness of ⅛ inch has been found to be sufficient for most applications.

A specific coating formulation which may be used comprises:

60 parts by weight of polyvinyl chloride plastisol
40 parts by weight of di-octyl phthalate
1 part by weight of stabilizer such as "Thermolite 31"

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which is an organo-tin chemical sold by the Metal and Thermit Co. of New York, N.Y.
5 parts by weight of mineral spirits such as Apco thinner

The plasticizer used is one which is relatively ineffective at room temperatures. However, when an anode which is heated to 350° to 400° F., for example, is dipped into the dispersion, the heat increases the activity of the plasticizer and a resinous coating is formed on the hot surface of the anode.

While the coating of the general type described above proves very satisfactory, other coatings may be used. For example a coating may be applied by hot dipping an anode into an ethyl cellulose gel lacquer. Alternatively, the anode may be coated with neoprene which has an advantage in that such a coating would be relatively immune to attack by light hydrocarbons. Specifically neoprene coated galvanic anodes are well adapted for use in cathodically protecting gasoline tanks or compartments in tank ships.

As cast, dip coated anodes in accordance with this invention often contain a groove 31 in their top surface 32 which is disposed about ¼ inch from the peripheral edge of the anode body. The groove 31 is about ⅛ inch wide and about ⅛ inch deep. When the coating or cover 26 is applied by dipping (or spraying, painting, etc.) the groove 31 becomes filled with a rib 33 of the coating material. During use, the rib 33 of coating which extends into the groove 31 lengthens the ion path through the electrolyte to the upper edge of the anode body 22. As the anode body 22 is consumed, the peripheral surface portion of the body tends to remain as a shell to keep the plastic cover 26 tightly in place over the anode body 22. The result is a neater anode which has more resistance to tearing of the cover 26 from the anode body 22 than does a partly consumed anode in which the sides of the anode body 22 are consumed and the cover becomes loose.

One of the advantages of anodes made in accordance with this invention is illustrated in Fig. 5. As the plastic covered anode 20 is consumed during use, the surface 32 of the anode which lies below the apertures is primarily consumed, leaving relatively untouched the anode surface under that part of the cover 26 where there are no apertures 28. While the entire upper surface of the anode body 22 will eventually be consumed, the surface area under the apertures 28 in the cover 26 will be "eaten away" the fastest. The result is that the magnesium anode body 22 will remain firmly bonded to the cores 24 even though the distance between the surface 32 and the bottom 34 of the anode on either side of the cores 24 is less than the space between the core 24 and the bottom surface 34 of the anode. In an anode 20 of the above type, almost the entire body weight of the anode gives useful cathodic protection.

Fig. 6 illustrates an anode 20 of the type shown in Fig. 1 as attached to a ship's hull 36. The anode is attached by welding the ends of mounting straps as at 38 to the hull. Because anodes made in accordance with this invention require no additional insulation device or electrical control to separate them electrically from the cathodic surface, the cost of the anode installation, particularly the labor cost, is materially reduced as compared with the cost of installing a bare anode.

The theory concerning the operation of the anodes of this invention is not fully understood. As has been observed, for an electrolyte of given electrical conductivity and assuming a cathodic surface to be protected which is large with respect to the anode, the current output of the anode 20 may be controlled by regulating the number and size of the apertures, thus controlling the flow of current from the surface of the anode 20. The top surface of the anode is conveniently used for this purpose. It is also known that the current output of various parts of the anode surface may be controlled by the size and num-

ber of apertures 28 above the various parts of the anode surface.

Data is given concerning operation of anodes of this invention under both depolarized and polarized conditions. As the term is used herein, depolarized conditions are those in which the anode and cathode are each at their natural potential while uncoupled in sea water. Under polarized conditions, as the term is used herein, the anode is at its natural potential while the cathode is at a potential which is a function of both the current density and the length of time the current from the anode has been flowing to the cathode. In the tests made for the purpose of gathering data for the graph in Fig. 14, it was found that after 24–30 hours the potentials tended to remain constant as if a steady state condition of operation had been reached.

The graph shown in Fig. 10 shows the relationship between the anode current (in milliamperes) and the "exposed anode surface area" (measured in square inches of opening in the cover 26) for different types of anodes. The term "exposed anode surface area" as used herein refers to the area of the apertures in the coating. It is realized that in partly consumed anodes, however, the surface area exposed to electrolyte may be larger than the aperture area. The ion path to the cathode remains the same (i.e., through the apertures). The coated anode data for the graph in Fig. 10 were obtained by varying the number of 5/8 inch diameter apertures 28 in the top surface 32 of a coated anode. However, the current line 40 in Fig. 10 is approximately the same when apertures 28 of other diameters (but of the same total area) are used.

As a practical matter, the aperture diameter is chosen depending upon at least two factors. First, the strength of the covering 26 of the anode should be maintained at a high value in order to lessen the tendency of the cover 26 to tear away from the anode body 22 when subjected to external forces. Secondly, the apertures 28 must be large enough to permit the anode corrosion product to be washed out of the casing. The anode material may influence the characteristics of the corrosion product.

For anodes used in moving water, cover apertures 28 which are 5/8 inch in diameter have proven very satisfactory. The thickness of the cover 26 may vary according to the material used and the installation of the anode, that is, whether the anode will be used in quiet or fast moving electrolyte. In anodes coated with a polyvinyl chloride type coating a thickness of .09 inch proved satisfactory for use in water moving at a speed of 25 feet per second.

In tests of bare anodes and coated anodes placed in sea water under the same operating conditions, it has been found that substantially no calcareous coating builds up on the cathodic surface around a coated anode mounted against a steel bulkhead in sea water while a substantial calcareous coating is built up around an uncoated or bare anode.

While the existence of a calcareous coating is evidence of excessive current, it is also evidence of paint damage and unsightliness. To the owner of small sea-going craft, the physical appearance of such craft is of prime importance. Anode currents strong enough to cause calcareous deposits cause the deterioration of the paint on that portion of the hull which is in the high current density area. The results have been that most ship owners have heretofore been reluctant to solve their hull corrosion problems at the expense of having an unsightly hull or damaged paint.

As is clearly seen from Figs. 11, 12 and 14 the current density on the cathode close to the coated anodes is only a small fraction of the current density on the cathode close to the bare anode under both polarized and depolarized conditions of operation. As seen in Figs. 11 and 13, the use of a perforated coated anode results in a substantial saving in "close-in" current over a resistor restricted bare anode of equal current output.

Fig. 11 shows the percent of total current versus distance from the anode under depolarized conditions. It may be seen from this graph that although coating the sides of the anode results in a considerable saving in current at distances close to the anode, the coated and perforated anode of this invention results in a further and substantial reduction of the current to cathodic surfaces which are close to the anode. Bare anodes are even more wasteful of their current output.

The anode test setup used in securing the data for the graphs of Figs. 11–14 comprised a series of concentric annular cathode segments made of steel with the test anode mounted in the center of the annular cathode segments. The cathode segments were insulated from each other and each had a flat top surface approximately 3 inches wide (as measured radially from the center of the annulus). The test setup included 8 of such cathode segments, mounted concentrically as stated above. When the graphs of Figs. 11–14 inclusive are read, it should be remembered that the current density readings are actually for areas rather than for points as might be assumed from the distance scales on the graphs.

In the gathering of the data for Figs. 11–14, a steel cathode was used and all the anodes used in the tests were identical in size and shape. The anodes were cylindrical in shape, having a diameter of 3 inches and a height of 4 inches, and were made of cell grade magnesium. One anode was bare, one anode had its side coated and top bare, and one anode was entirely coated and contained all the 5/8 inch diameter perforations which could conveniently be made in the top surface thereof with 5/16 inch spacing between adjacent apertures. The bottom surface of each of the anodes was coated to protect that surface from the cathodic surface to which the anode was mounted. The measurements were made with the anodes immersed in sea water moving at a rate of approximately 6 ft./minute. In those graphs where current values are given, no attempt should be made to relate the currents to that current which is necessary to protect the cathodic surface. The experimental data shows only current distribution from the anode without regard to the current required to achieve protection. Obviously, if more current is needed, larger anodes may be used.

Fig. 12 shows current density versus distance from anode under depolarized conditions of operation. The graphs of Figs. 11 and 12 were plotted using the same experimental data. It should be noted in Fig. 12 that the current density close to the anode (3 inches from the anode) is about 7 times as high for a bare anode as for a perforated and coated anode, in which the perforations were placed as described above. Also, a perforated and coated anode puts a larger part of its output current farther away from the anode than does the bare anode. This larger far-out current tends to increase the cathode area protected by a coated anode as compared with bare anodes of similar current capabilities. It should be realized that in the graphs of Figs. 11 and 12 the total output current of each of the anodes is different from the output current of the others.

The graph shown in Fig. 13, however, shows current distribution under depolarized conditions in the case of equal total currents of a bare anode whose current output is restricted by a series resistor and a perforated coated anode. It should be noted that the "close-in" current of the perforated coated anode, that is, the current going to the cathodic surface which is closely adjacent to the anode, is considerably lower than the close in current of the resistor-restricted anode. This graph indicates that the resistor in the resistor-restricted anode apparently restricts only the total current output of the anode and has little effect on the current distribution pattern of the anode. Compared with Fig. 11, the percent of current output curve for the bare anode is very similar to the corresponding curve for the resistor-restricted anode. Referring again to Fig. 13, it may be seen that in the case

of the coated and perforated anode only about 8 percent of the total current was used within 3 inches of the anode whereas about 23 percent of the total current of the resistor-restricted anode is utilized in the same area within 3 inches of the anode.

Considering the current distribution curve of Fig. 13, it appears to now be feasible to install anodes on surfaces which remain depolarized and still achieve long lived protection. Previously on such continually depolarized surfaces, such as on a ship's rudder, the anodes were quickly depleted due to the excessive close-in current. Anode life of bare anodes in such installations was much less than the anode life of bare anodes when installed adjacent to polarized surfaces. Since ship anodes may be installed conveniently only when the ship is in dry dock, the result has been that ship hulls have not been protected as uniformly as desired because of inability to replace anodes which were rapidly depleted. The coated and perforated anode provides an answer to this problem by providing a controlled distribution of current and thereby making possible more uniform protection of a ship's hull or other cathodic surface.

A comparison is shown in Fig. 14 between a coated and perforated anode and a bare anode of equal size regarding current density versus distance under polarized conditions of operation. Fig. 14 shows that the close-in current of the bare anode at 3 inches distance from the anode is about 4 times the close-in current of a coated and perforated anode. Thus, even under polarized conditions of operation, the bare anode is quite wasteful in the usage of its current output in providing close-in protection to a cathodic surface.

It should further be remembered that under conditions where the cathodic surface is in rapidly moving electrolyte, as for example on the hull of a ship, the hull seldom becomes completely polarized.

Another practical advantage accrues to the use of coated and perforated anodes which is not apparent from the graphs. Often the cathodic surface to be protected is coated, as by painting, and the coating effectively reduces the area of the exposed cathodic surface so far as anode current requirements are concerned. However, when high close-in currents occur, the coating peels off and an enlarged, bare cathodic surface is presented to the anode. The bare surface in return requires more total current from the anode in order that the bare surface be adequately protected. Because of the substantial reduction in close-in current when anodes of this invention are used, the paint or coating on the cathodic surface is relatively unaffected. It should be realized, however, that a very few brands of paint that were tested peeled off with even very low current to the cathodic surface.

To cite an example of the different current requirements for equal area surfaces, a galvanized water tank may, and often does, require 10 times the anode current for effective protection as does a glass lined water tank of equal size. A painted surface would not be as good as a glass lined surface in reducing the current required for protection. However, it can be appreciated that any loss of paint from the cathodic surface would increase the anode current demand and, if effective protection is to be maintained, would shorten the effective life of the anode. Thus, the fact that paint is not removed from the cathodic surface when coated and perforated anodes are installed results in further important advantage in extending the life of the anode.

The galvanic anode structures thus far described have been of the type which are bolted, welded, or otherwise fixedly attached to a structure which is to be cathodically protected. Referring to Fig. 7, there is shown a plastic coated galvanic anode 42 of generally cylindrical form. A metal mounting strap or cable 44 extends from the anode body and is fixed therein. The plastic coating or covering 46 of the anode is provided with perforations 48 (apertures) in order to regulate the current flow from

the anode as previously described in connection with other coated and perforated anodes. The plastic coating 46, as illustrated, usually extends at least part way along the mounting strap or cable 44. The plastic coating or covering of the anode 42 also provides an anode which is cleaner to handle than is a bare anode. It is anticipated that anodes of the type shown in Fig. 7 will find use as readily demountable anodes for use on small vessels. In this type of application, the anodes would normally be stowed away except when the vessel was anchored or tied up at a dock or pier. The anode strap would then be fastened to a cleat mounted on the metal hull of the vessel completing the protective electrical circuit. Such an anode arrangement has merit for small craft use, since many pleasure craft are docked or anchored far more hours than are operated. The demountable anode provides cathodic protection, yet may be removed easily so there is no extra "drag" in the water. The plastic covered anode is neater and more desirable, from a housekeeping standpoint, than is a bare anode. Further, since galvanic anode surfaces become roughened during their consumption and often have small, sharp edges, the plastic coating over the anode results in an anode assembly which is safer to handle than a bare anode. The anode structure may be included as part of or combined with the fenders of the vessel if desired, thus eliminating a separate object to be stowed while the vessel is in use. The covering 46 of the anode 42 need not be applied by dipping the anode body in liquid plastic, but may comprise a permanent casing in which bare anodes may be disposed. Anodes and casings of this general type are described and claimed in applicants' copending application, Serial No. 485,438, filed February 1, 1955.

While the advantages of the coated and perforated anodes of this invention have been described mainly in connection with ship hulls, such anodes have many other applications.

For example, coated anodes having no perforations may be stock piled and stored without shelter from the weather for long periods of time without loss of anode weight by corrosion. Such anodes are provided with perforations of the required number and size at the time they are sold (or are to be used) for the particular installation in which they will be utilized.

Different corrosion prevention applications require anodes of many different varieties of performance characteristics. To stock all types of anodes would place a considerable financial burden on a distributor or dealer. However, when a distributor stocks coated but unperforated anodes in accordance with this invention, a minimum number of anode types and sizes serves to supply the anodes for a wide variety of application situations when the anodes are given the required perforation pattern.

The availability of an unperforated coated anode is also attractive to corrosion engineers who prefer to maintain some degree of secrecy about their ideas as to what is the best solution to a particular corrosion problem.

Coated and perforated anodes may be used in many applications where resistor-restricted anodes or bare anodes are now used. Pipe line cathodic protection systems can make use of the anodes of this invention by mounting the anodes closer to the line than heretofore has been practical because of the excessive local current to the nearby pipe.

The use of a coated and perforated anode in a water tank is illustrated in Fig. 8. The anode, indicated generally by the numeral 50, extends upwardly from the bottom of the tank 52, but could be mounted to extend downward from the top of the tank. In either method of mounting, excessive current used by flows to the mounting end of the tank because the surface 54 from which the anode 50 is mounted is closer to the mounting end of the anode 50 than are the sides of the tank 52. Thus,

the lower end of the coating 56 on the anode 50 in the tank has smaller apertures 58 than appear in the coating over the remainder of the anode. The smaller apertures 58 near the bottom end of the anode restrict the current which flows from that part of the anode, thus causing a more uniform expenditure of the anode than would occur if the anode apertures were all uniform in size. Such selective current flow from the anode 50 would not be possible in a resistor-restricted anode. In addition, the coating 56 provides physical support for the anode 50.

Fig. 9 illustrates a cable-core coated and perforated anode, indicated generally by the numeral 60, made in accordance with this invention. The anode coating 62 extends along the mounting cable 64 for a considerable distance from the anode body 66 to prevent strong local current flow between the anode and the nearby mounting cable 64. Such cable anodes are well adapted to be clamped to a submersible metallic net, for example. The size and number of perforations 68 of the anode may be varied to accommodate a wide variety of corrosion control situations.

Any of the anode assemblies described above may be coated with an anti-fouling coating in addition to or as a substitute for the previously described coatings. An anti-fouling coating which is suitable for use on anodes for use in sea water is a copper salt of polyacrylic acid. Such coatings can be made relatively insoluble by controlling the degree of polymerization of the coating material. The coating is physical tough and has a double anti-fouling action. The copper is toxic to small marine oragnisms and since the surface of the coating dissolves at a slow rate, the organisms cannot readily adhere to the coating.

As a precaution against baring the anode due to the dissolving of the anti-fouling coating, or because of the electrical properties of some coatings it is sometimes advisable to provide an under coating of normally insoluble material (such as described previously herein, for example), prior to applying the anti-fouling coating.

Another anti-fouling coating may be provided by dispersing copper particles through the non-soluble coating materials.

Another use of slowly soluble coating materials is to provide a delayed action anode for use in installations where mounting the anodes is expensive or can be done only at infrequent intervals. Thus, an immediately operative anode and a "delayed action" anode may be installed together with a coating on the delay action anode which is calculated to expose the galvanic metal of that anode at approximately the time of the end of the useful life of the immediately operative anode.

Fig. 15 illustrates an anode 22 having a coating consisting of two layers or laminations 26*a*, 26*b*. The layer 26*a*, which, as illustrated, contains one or more apertures 28, is the less soluble of the two layers. The outer layer 26*b* is the more soluble layer, covers the inner layer 26*a* and fills in the aperture or apertures 28.

It is now customary to attempt to achieve long-lived cathodic protection by the use of larger and larger anodes. Larger anodes, while providing protection over a longer period than do smaller anodes, have higher current flow and thus are inefficient. Two small anodes, one of them a delayed-action anode, may be used to provide continuous protection without the inefficiency of a single large anode.

Among the suitable coatings which will slowly dissolve are polyacrylic acid (or salts thereof), polyvinyl alcohol, methyl cellulose plus enzyme, or natural gums plus bacteria. Arayakraya is an example of a natural gum which may be used. It is relaized that not all the above coating materials are suitable for use in mobile installations such as ships. However, many stationary or seldom moved metals in sea-water or other saline electrolyte may be given long range protection by such delayed action anodes.

Delayed action anodes may likewise be used in tanks which are used to store or transport petroleum products or other materials. The anode coating for such delayed action use is chosen from substances which have low solubility rates in the electrolyte to which they will be exposed.

Thus, it is apparent that the present invention provides improved galvanic anodes which have longer life, have better current distribution, are easier to store, and are more adaptable to a wide variety of corrosion control situations than are conventional bare anodes or resistor-restricted anodes.

This is a division of my copending application, Serial No. 485,373, filed February 1, 1955.

I claim:

1. An article for use in the cathodic protection of metal surfaces immersed in an electrolyte, comprising a galvanic anode assembly including a galvanic anode body, a metal core bonded into said body, and a closely fitting, electrically insulating covering surrounding said anode body, said covering being a laminated covering having an inner layer and an outer layer, said covering being soluble in said electrolyte, the inner layer being substantially less soluble in the electrolyte than is the outer layer, the outer layer entirely covering said anode body.

2. An article in accordance with claim 1, wherein said inner layer is composed of vinyl dispersion resin and said outer layer is composed of polyacrylic acid.

3. An article in accordance with claim 1, wherein said inner layer is composed of vinyl dispersion resin and said outer layer is composed of polyvinyl alcohol.

4. An article in accordance with claim 1, wherein said inner layer contains a plurality of apertures.

5. An article in accordance with claim 4, wherein each of said apertures has an area exceeding the area of a circle having a diameter of one-eighth inch.

6. An article for use in the cathodic protection of a metal surface immersed in an electrolyte, comprising a galvanic anode assembly including a galvanic anode body, a metal core bonded into said body, and a closely fitting, electrically insulating covering surrounding said body, said covering being a laminated covering having an inner layer of vinyl dispersion resin and an outer layer composed of a copper salt of polyacrylic acid.

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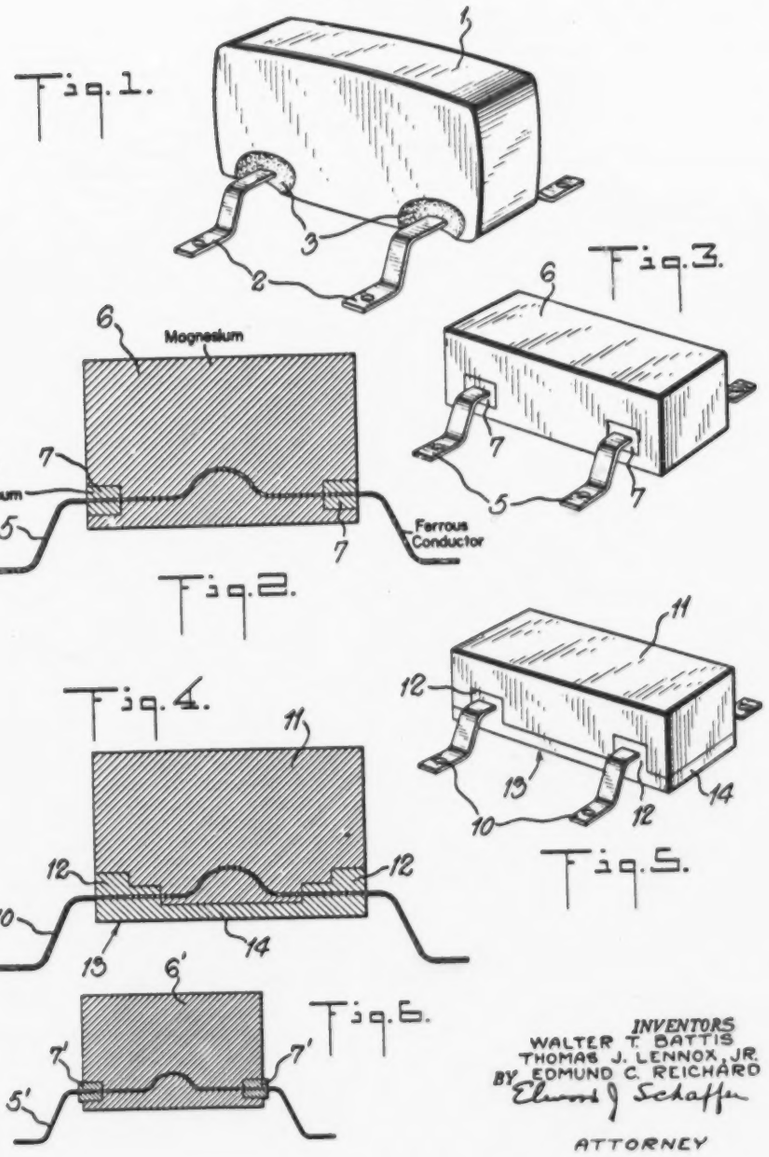
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Sept. 26, 1961 W. T. BATTIS ET AL 3,001,924

SACRIFICIAL MAGNESIUM ANODES

Filed April 1, 1959



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3,001,924
Patented Sept. 26, 1961

3,001,924

SACRIFICIAL MAGNESIUM ANODES

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Filed Apr. 1, 1959, Ser. No. 803,505
3 Claims. (Cl. 204—197)

This invention relates to a sacrificial anode comprised of magnesium and more particularly to an improvement in the connection for electrical conductor thereof.

Sacrificial anodes having a ferrous conductor projecting therefrom generally are fabricated by casting a body of metal comprising magnesium around one or more steel brackets so that a portion of each bracket is embedded in the body of magnesium metal with the remaining portion of each bracket projected therefrom. In use, the anode is electrically connected to a less noble structure to be protected, usually a ferrous structure, by suitably attaching the projecting end or ends of the bracket or brackets to the structure, as by bolting or welding, so that the bracket or brackets may serve both as an electrical conductor and a support for the body of sacrificial metal. When the electrical circuit between the anode and the structure is completed by an electrolyte, the resulting current established by galvanic action flows from the anode to the structure and maintains the latter cathodic at the expense of the anode which is progressively dissolved, i.e., sacrificed, so that corrosion of the structure is reduced or prevented.

It has been found that where such anodes are fabricated with brackets comprising ferrous metal, for example, iron, steel or other ferrous metal, accelerated local corrosion occurs at the magnesium metal-bracket interface when the anodes are in use, especially in sea water and particularly in running sea water. It has been found that such local corrosion occurs whether or not bare or galvanized brackets are used in fabricating the anode; and that this corrosion may be so severe that in a comparatively short time the anode becomes loose on its brackets with the result that the anode becomes ineffective and fails in that current flow from it to the cathode is reduced or stopped. In most instances in protecting a structure from corrosion in sea water, such local corrosion causes the anode to fail before the body of the magnesium metal has been consumed and, in running sea water, much before the magnesium metal has been half consumed. As a result of such failure, a large portion of the body of magnesium metal is wasted and the structure or portion thereof served by the anode is without protection until the latter is replaced. In addition, such local corrosion, even if failure does not occur, represents a wasteful and inefficient use of the magnesium metal.

The principal object and advantage of the invention is that it provides an anode in which such local corrosion is greatly reduced or eliminated. Another object and advantage of the invention is that it provides an anode in which the body of sacrificial metal is used more efficiently. A further object and advantage is that the structure to be protected is provided with more effective protection by the anode of the invention. These and other objects and advantages will become apparent from the following more detailed description of the invention.

Broadly, the improvement comprehended by the invention is the provision in the body of the anode of a plug of metal which is less active galvanically than magnesium, the plug being at least partially embedded in the body of the magnesium metal of the anode and surrounding the ferrous conductor in the portion of the anode where the conductor emerges from the anode. While a

portion of the plug may project beyond the body of the anode, it is essential in obtaining satisfactory reduction of local corrosion where the conductor emerges from the anode that at least a portion of the plug be disposed within the body of the anode.

Good results are obtained with a plug which surrounds the conductor with at least ¼ inch of plug metal. Enhanced results are obtained when the conductor is surrounded with at least ½ inch of such metal and in most instances a plug which surrounds the conductor with ½ to 2 inches of metal is adequate. Good results are also obtained when the plug surrounding the conductor extends at least ¼ inch into the body of the anode. Preferably, the plug extends at least ½ inch into the body of the anode and most preferably each plug extends into the anode for at least about one-quarter of the length of the portion of the conductor which is embedded in the body of the anode.

Any metal which is less active galvanically than the body of the sacrificial metal may be used. Thus, with a body of sacrificial metal comprising magnesium, the plug metal may be, for example, a metal comprising zinc, cadmium, aluminum, lead, or tin, or their alloys. For best results, however, the plug metal is also more active galvanically than is the metal of the electrical conductor. The preferred plug metal for a ferrous conductor is one which is composed predominately of zinc or aluminum. For example, the preferred plug metal may be commercially available aluminum or aluminum alloyed with up to 6% zinc; or it may be commercial pure zinc or zinc alloyed with up to 0.5% aluminum or up to 0.2% cadmium, or both of these alloying constituents. Most preferably, the plug metal is composed of commercially pure zinc or a zinc alloy.

The body of magnesium metal in the anode may be composed of magnesium or a magnesium-base alloy. Preferably, it is composed of a magnesium-base alloy which, most preferably, contains up to 10% aluminum and up to 5% zinc as alloying constituents. The anode may be fabricated in any desired manner although best results are obtained by conventional casting procedures. Thus, in the preferred mode of fabrication, the conductor or conductors are placed in a desired position of the mold cavity of a suitable mold. The mold cavity is also provided with suitable spacers around the conductors corresponding to the position of the plug metal which is ultimately cast therein. The magnesium metal is then cast about the conductors and, after solidification, the spacers are removed and the plug metal is cast in the space formerly occupied by the spacers. Upon solidification of the plug metal, the finished anode is removed from the mold.

The invention is further illustrated in the accompanying drawings and in the following examples. It should be understood, however, that the drawings and examples are given for purposes of illustration and that the invention in its broader aspects is not limited thereto.

In the drawings:

FIG. 1 is a perspective view of an anode showing the local corrosion which occurs in the absence of the invention;

FIG. 2 is a transverse cross-section of an anode employing the invention in its preferred form;

FIG. 3 is a perspective view of the anode of FIG. 2;

FIG. 4 is a transverse cross-section of another anode employing the plug metal of the invention;

FIG. 5 is a perspective view of the anode of FIG. 4; and

FIG. 6 is a view similar to FIG. 2 showing an anode employing the invention in an alternative form.

Referring now to the drawings, in FIG. 1 there is shown

a conventional anode as it appears after a short period of use. The numeral 1 represents a body of sacrificial metal comprising magnesium, and 2 represents ferrous metal electrical conductors which also serve as means for supporting the anode on the structure to be protected. The area designated by the numeral 3 illustrates the local corrosion that occurs at the magnesium metal-bracket interface.

FIGS. 2 and 3 illustrate an anode employing the invention, which anode is especially useful in protecting ship hull surfaces. The ferrous metal brackets 5 embedded as shown in the body of the magnesium metal 6 are provided with plugs 7 of a metal less active galvanically than the body of the magnesium metal. In use, the projecting ends of the brackets, are attached, as by bolting, to the structure to be protected so as to support the body of the sacrificial metal away from the structure and also to electrically connect the sacrificial metal to the structure.

In FIGS. 4 and 5, a portion of the ferrous metal brackets 10 are also embedded in the body of magnesium metal 11. In addition to surrounding the brackets in portions 12 of the anode where the brackets emerge therefrom, the plug metal 13 also covers the surface 14 which is intended to be placed against the cathodic surface to be protected. The anode illustrated in FIGS. 4 and 5 is most advantageously used to protect the exterior of ship hulls. In use, the projecting ends of the anodes are attached to the exterior of the hulls with the bottom of the anode held tightly against the hull.

An anode employing the invention in an alternative form is shown in FIG. 6. As shown in this figure, a portion of the body of the plug metal 7' projects outside of the body of the magnesium metal 6'.

Two 44 pound anodes of the type illustrated in FIGS. 4 and 5 were fabricated by conventional casting procedures. The anodes were generally rectangular in shape. The sacrificial magnesium metal was a magnesium alloy containing 6% aluminum, 3% zinc and the balance commercial grade magnesium. The brackets 10 were bare steel (so-called black iron) brackets. The magnesium alloy was cast about the brackets so that the middle portion of each bracket was embedded in and surrounded by the magnesium alloy. Suitable spacers were placed in the mold cavity prior to casting the magnesium alloy so as to enable the plug metal 13 to be subsequently cast about the brackets in the portions 12 of the anode and also to cover surface 14. After the magnesium metal was cast, the spacers were removed, and the plug metal was cast on the anode in the position shown in FIGS. 4 and 5. In each of the portions 12, the plug metal extended along and surrounded the bracket 10 for a distance of 1¾ inches. Also in each of the portions 12, the outermost portion of the plug metal was 3½ inches wide by 2 inches deep and, in the innermost portion, the plug metal was 3½ inches wide and 1¼ inches deep. In one anode the plug metal was commercial grade aluminum and in the other high purity zinc metal containing 99.99+% zinc was used.

Each of the thus prepared anodes was mounted on 4 foot x 4 foot x ⅛ inch cold rolled steel plates with the bottom 14 (see FIG. 5) of each anode held tightly against the plate. The plates with the anodes were then immersed in a flume of running sea water for four and one-half months. At the end of this period the plates were removed from the flume and the anodes examined. It was found that more than half of the body of the sacrificial magnesium metal in each of the anodes was consumed in affording galvanic protection to the plates but that no local corrosion of the magnesium metal or the plug metal occurred where the brackets 10 emerged from the body of the anode.

The foregoing results are to be compared with the results obtained in a similar test with an anode which was otherwise the same as the two foregoing test anodes except that no plug metal was used. Within 80 days local corrosion of the type illustrated in FIG. 1 had occurred to such an extent that the anode became loose on brackets 2 (see FIG. 1). Likewise, in another similar test with anodes having plug metal cast in the brackets against the body of the magnesium metal but not recessed therein, it was found that local corrosion also occurred at the interface between the plug metal and the body of the anode.

What is claimed is:

1. In a sacrificial anode having a body of sacrificial metal comprising magnesium and a ferrous metal conductor projecting from the anode with a portion of the conductor embedded in the body of said sacrificial metal, the improvement comprising a plug of metal which is less active galvanically than magnesium and more active galvanically than said ferrous metal conductor, said plug being at least partially embedded in said body of magnesium metal and surrounding said conductor in the portion of the anode where the conductor emerges therefrom.

2. A sacrificial anode according to claim 1 in which said plug comprises a metal selected from the group consisting of zinc and aluminum.

3. A sacrificial anode according to claim 1 in which said plug surrounds said conductor with at least ¼ inch of plug metal and said plug extends at least ¼ inch into the body of the anode.

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July 27, 1965 B. R. FAIRCHILD 3,197,262

PIPE PROTECTOR

Filed Nov. 5, 1962 3 Sheets-Sheet 2

Fig. 5

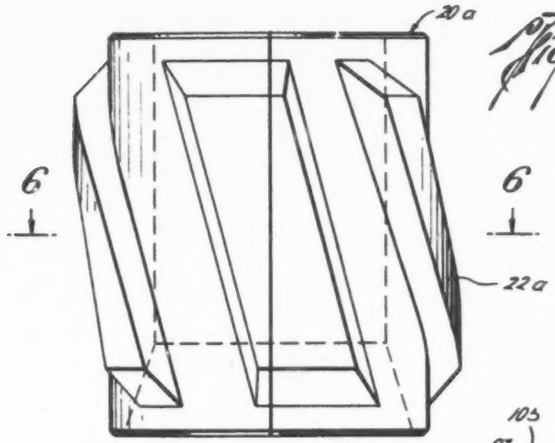


Fig. 6

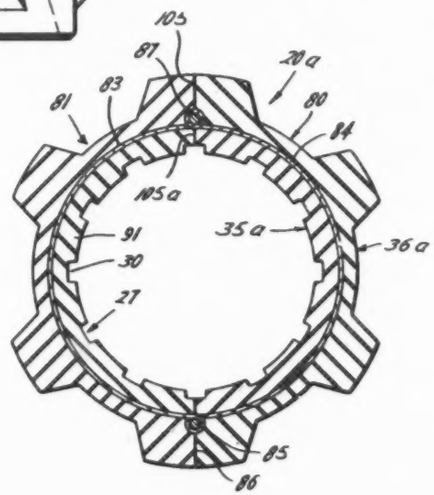
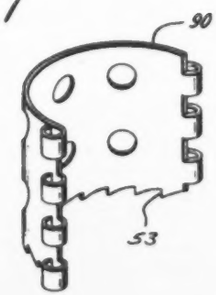


Fig. 7



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PIPE PROTECTOR

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Fig. 8

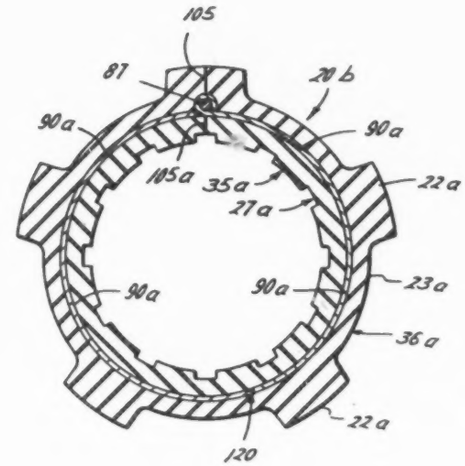
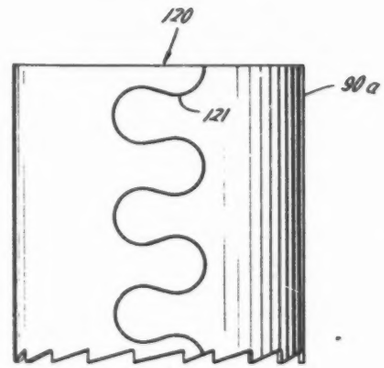


Fig. 9



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3,197,262
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3,197,262

PIPE PROTECTOR

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Filed Nov. 5, 1962, Ser. No. 235,418
4 Claims. (Cl. 308—4)

The present invention relates to a protector for tubular members, and more particularly, to a protector particularly adapted for use with drill pipe sections.

In the drilling of oil, gas, and water wells by the rotary method, the well bore or hole in the earth's surface is formed by means of a drill bit which is secured on the end of what is called a drill string. The drill string is formed of a plurality of drill pipe sections which are connected dr coupled together in any suitable manner and more generally by means of male and female threaded portions at each end of each drill pipe section to enable the drill pipe sections to be connected together.

As the well bore is progressively deepened by drilling operations, additional pipe sections are added to the drill string at the earth's surface so that the drill bit or cutting tool at the lower end of the drill string will be maintained in proper engagement with the bottom of the well bore until it is drilled to the desired depth. During the drilling ope ations, the drill string is rotated at the earth's surface, and this rotation is transmitted to the bottom of the drill string to effect the drilling action by the bit.

Since the drill pipe sections may be reused, it is desirable to inhibit excessive wear or damage thereto, and one means employed to prevent excessive wear or damage to the drill pipe section is to position on the drill pipe devices termed pipe protectors which aid in centralizing the drill pipe section within the well bore, thereby inhibiting unnecessary rubbing action against the wall of the well bore as the drill string is rotated. Where the drill string is rotated in a portion of a well bore which is provided with a surrounding casing, it can be appreciated that excessive rubbing or wearing by the drill string on the casing may damage it to an extent so that it is not safe for future use.

The pipe protectors heretofore employed generally are of the type which are adapted to be positioned on the drill pipe section by inserting the drill pipe over the end of the section and thereafter seating it on the drill pipe section at any desired location. Such drill pipe protectors normally are formed of a material such as hard rubber with the tubular body thereof having an opening which is somewhat smaller than the normal diameter of the drill pipe section on which it is to be positioned so that after the drill pipe protector is positioned on the drill pipe section, it will firmly grip the drill pipe section and rotate with the pipe section as it is rotated in the well string.

The connecting or coupling means formed at each end of the drill pipe section is generally of a larger outer diameter than the outer diameter of the drill pipe section itself, and it can be appreciated that in order to position the drill pipe protectors on the drill pipe section, it is necessary to initially expand them sufficiently so that they may be first positioned over the enlarged area at the end of the drill pipe section and thereafter permitted to collapse on the smaller diameter portion of the drill pipe section.

This construction of the drill pipe section and the manner of positioning the drill pipe protectors on the drill pipe section creates undesirable problems in connection with the use of protectors. For example, it is extremely expensive and time consuming to initially position the pipe protector on the drill string and to remove the protector from the drill string when desired.

Also, the construction of present pipe protectors and

their arrangement on drill pipe sections creates certain stresses and tensions in the protector itself so that it tends to rupture more readily or wear more readily during normal use thereof. It can be appreciated that the drill pipe string is rotated at times at a fairly high rate of speed, and since the drill pipe protector rotates with the drill string, it may be subjected to substantial shock bumping against the sides of the well bore in addition to the ordinary frictional engagement of the protector with the well bore wall during rotation of the rotating drill string.

One of the objects of the present invention is to provide a pipe protector for tubular member such as a drill string which may be positioned on a drill string in a manner to accomplish its desired function without setting up any stresses or strains in the protector which might cause the protector to wear or rupture more readily.

Still another object of the present invention is to provide a free floating pipe protector for a drill string which is constructed and arranged so that it may move longitudinally relative to the pipe on which it is positioned.

Yet a further object of the present invention is to provide a pipe protector adapted to be positioned on a drill string to inhibit wear to the drill string, which pipe protector is constructed and arranged so that it may be readily drilled off the drill pipe section in the event the drill pipe becomes stuck during drilling operations.

Yet a further object of the present invention is to provide a drill pipe protector for drill pipe which may be quickly and easily positioned in place on a tubular member.

Still another object of the present invention is to provide a drill pipe protector which creates a minimum of interference with the normal operation of a drill pipe string and causes a minimum of flow interference with drilling fluids used in the drilling of the well but which accomplishes its intended function.

Other advantages and objects of the present invention will become more readily apparent from a consideration of the following description and drawings wherein:

FIG. 1 is a vertical sectional view of a portion of a well bore illustrating a form of the present invention positioned on a drill string;

FIG. 2 is a vertical sectional view illustrating a form of the invention;

FIG. 3 is a top end view of the form of the invention illustrated in FIG. 2;

FIG. 4 is a fragmentary perspective view of an inner portion of the pipe protector shown in FIGS. 2 and 3 of the drawings;

FIG. 5 is a side view of an alternate form of the present invention;

FIG. 6 is a sectional view on the line 6—6 of FIG. 5 illustrating in further detail the form of the invention there illustrated;

FIG. 7 is an isometric view of a portion of the structure of the device shown in FIGS. 5 and 6;

FIG. 8 is a sectional view of still another form of the present invention; and

FIG. 9 is a side view of a portion of the structure illustrated in FIG. 8 of the drawings.

Attention is first directed to FIG. 1 of the drawings wherein a portion of a well bore 10 extending downwardly into the earth's surface is illustrated in vertical section. The drill string is represented generally by the numeral 15 and includes the drill pipe sections 16 which are connected or coupled together at their ends. As shown in the drawings, each drill pipe section 16 includes a female tool joint 17 and a male tool joint 18 at the opposite end, which female and male tool joints are respectively adapted to be engaged with the male and female tool joints formed on adjacent drill pipe sections 16 thereabove and therebelow.

The device of the present invention is illustrated by the numeral 20 in FIG. 1 and is shown as being positioned on the drill pipe section 16. The well bore 10 is illustrated as being open hole, but it can be appreciated that the present invention is adapted to be used on drill pipe or tubular well strings in well bore which is provided with casing that surrounds the tubular wall string as well as in open hole.

During normal drilling operations, rotation is imparted to the well string 15 and thus to the drill string section 16 so that rotation may be imparted to the drilling bit on the lower end of the well string or drill string 15. The present invention is constructed and arranged so that it aids in preventing the drill pipe section 16 from rubbing against the wall of the well bore 10 whether the well bore is cased or uncased. Also, the present invention is constructed so that it does not interfere with the normal flow of drilling fluid in the well bore 10 during drilling operations and is constructed so that it may move longitudinally of the drill pipe section on which it is positioned. Thus, during normal drilling operations with the well fluid circulating upwardly in the well bore, the upper end of the drill pipe protector 20 would abut against the lower end of the pipe joint on the upper end thereof and since the pipe protector is of a larger diameter than the diameter of the joint, this would inhibit rubbing of the joint against the well bore wall. It can be appreciated that one or more pipe protectors can be provided on each section of the drill string as desired in order to inhibit damage to the drill pipe during drilling operations.

In FIG. 1 of the drawings, the form of the device illustrated in FIGS. 2–4 is shown as being positioned on the drill pipe section 16; however, it can be appreciated that this is for purposes of illustration and any other embodiment of the present invention may be similarly employed without departing from the scope hereof.

In FIG. 2, and FIG. 3, the pipe protector designated generally by the reference numeral 20 includes a tubular member designated generally by the numeral 21 which is adapted to be positioned on the drill pipe sections 16. The tubular body 21 includes the longitudinally extending and radially projecting portions 22 which are separated by the longitudinally extending pressed or recessed areas 23 on the exterior surface designated generally by the numeral 24 of the tubular member whereby the drilling fluid circulated in the well bore may be conducted around the device with a minimum of interference. Similarly, fluid passage means designated generally by the numeral 27 are provided on the inner surface designated generally at 28 of the tubular member 21, such passage means being in the form of the grooves or recesses 30 which extend lonigtudinally of the inner surface 28 and are spaced circumferentially in any suitable manner in order that fluid flow between the drill pipe section 16 on which the device 20 is positioned, and the inner surface 28 of the device may be effected.

More particularly, the tubular member 21 is shown in the form of the invention illustrated in FIGS. 2–4 of the drawings as including an inner bushing designated generally by the numeral 35 which is adapted to be secured in position in the outer sleeve represented generally by the numeral 36. The inner bushing 35 is split as illustrated at 37 to form a plurality of longitudinally extending sections 38 and 39. If desired, the split 37 may define a recess 40 in one of the longitudinally extending sections 38 and a projection 41 on the other section so as to interfit with the recess 40 and thereby position the sections 38 and 39 together for reception in the outer sleeve 36 as will be described in greater detail hereinafter. As illustrated in FIG. 3 and FIG. 4 of the drawings, the inner bushing 35 is shown as being split in two semicylindrical sections; however; it can be appreciated that the inner bushing 35 may be split into as many lon-

gitudinally extending sections as desired without departing from the scope of the present invention.

Suitable means are provided for connecting the inner bushing 35 with outer sleeve 36 whereby the device 20 illustrated in FIGS. 2–4 may be quickly and easily secured in position on a drill pipe section 16 in a manner so as to inhibit dislodging of the drill pipe protector 20 from its position on the normal diameter portion 45 of the drill pipe section 16 which extends between the raised tool joint areas 17 and 18 at each end of the drill pipe section 16 as illustrated in FIG. 1 of the drawings. The outer sleeve 36 has an inner diameter 48 which is slightly larger than the outer diameter of the tool joint 17 or 18 provided at each end of the drill pipe section 16. Thus, the outer sleeve member may be readily slipped over the end of the drill pipe section 16 without stretching it or applying any other unusual force or pressure thereto. After the outer sleeve 36 has been slipped over the end of the drill pipe section 16, the inner bushing 35 comprised of the longitudinally extending portions 38 and 39 may then be positioned around the drill pipe for seating coaxially in the outer sleeve 36. This may be accomplished by moving the longitudinally extending sections 38 and 39 and outer sleeve relative to each other so that they may be engaged together. Suitable means is provided for locking or engaging the inner bushing 35 on the outer sleeve 36, and as illustrated in FIGS. 2 and 4 of the drawings, such means comprises the threaded portion 49 formed on the inner bushing 35 which is adapted to engage with the threaded portion 50 formed on the outer sleeve 36. Thus, the inner bushing 35 and outer sleeve 36 may be connected together, and when connected together, form the integral pipe protector 20 as illustrated in FIG. 2 of the drawings.

The inner lower end of the inner bushing 35 is tapered as illustrated at 52, such taper extending outwardly and longitudinally as illustrated in FIGS. 1 and 2 of the drawings. When the drill string is removed from the well bore, the upward movement of the well string or drill string 15 will cause the pipe protector 20 to move longitudinally downwardly relative to the drill pipe section 16 on which it is positioned and engage the coupling or enlarged portion at the lower end thereof. Thus, the pipe protector 20 will be positioned adjacent the portion of the drill string 15 which is of largest diameter, thereby inhibiting damage to the drill string as it is removed from the well bore.

Also, if the drill string becomes stuck in the well bore and it becomes necessary to "fish" the stuck drill string, the taper 52 will seat on the enlarged bore end of the drill pipe section 16 on which it is positioned, and a pipe cutting tool may be telescoped downwardly over the pipe protector 20 and drill or cut it off the pipe so that proper engagement with the stuck pipe may be attained. To enable cutting or drilling of the pipe protector 20, serrations 53 are formed on the lower end of the pipe protector, which serrations are normally covered as indicated in FIG. 2 of the drawings, but which serrations upon the application of unusual pressure, such as would be encountered by the application of a force from a cutter tool to the top of the pipe protector, move through the covering and engage the enlargement or tool joint 18 so as to stop relative rotation of the pipe protector 20 as it is cut or reamed off the drill pipe section 16.

The drill pipe protector 20 is formed of material such as metal, plastic, or rubber which is preferably softer than the material of the drill pipe string 16, and in the form of the invention illustrated in FIG. 2 of the drawings, it can be seen that the outer sleeve 36 includes a metal portion 55 with an outer hard rubber covering 56 formed thereon. The projections 22 and recesses 23 are formed in the outer rubber covering 56 of the outer sleeve 36 as illustrated in the drawings.

Similarly, the inner bushing 35 includes a metal portion 57 and a rubber covering 58 of suitable thickness

thereon, the rubber **58** being of suitably hard rubber to withstand normal wear and tear.

The inner diameter of the bushing **35** as represented by the dimension **60** is slightly greater than the outside diameter of the portion **45** of the drill pipe **16**, but it is smaller than the outer diameter of the pipe joints **17** and **18** so that it will not move from one drill pipe section **16** to the next during rotation of the well string **15** in the well bore.

In FIGS. 5 through 7, an alternate modification of the device is represented by the numeral **20***a*. The device includes portions which may be termed as the outer sleeve **36***a* and the inner bushing **35***a*. It will be noted that the outer sleeve **36***a* and the inner bushing **35***a* are illustrated as being formed into two semicircular portions represented generally by the numerals **80** and **81**, respectively. In the modification illustrated in FIGS. 5 through 7 of the drawings, the outer sleeve **36***a* is formed entirely of a surfacing material such as plastic, rubber, or some metal softer than the material from which the drill string **15** is formed, and the projections **22***a* are shown as extending circumferentially and at an angle relative to the longitudinal axis of the outer sleeve **36***a*, the angle of inclination varying as desired and as shown in the drawings approximates 15 to 18 degrees.

The inner bushing **35***a* is formed by the semicircular metal portions **83** and **84** which are hinged or pivoted together at **85**, and it is to be noted that the outer sleeve **36***a* is split as indicated at **86** to conform with the longitudinal pivot or hinge arrangement of the inner bushing **35***a*. This permits the device **20***a* to be opened so that it may be positioned about the drill pipe and thereafter it may be closed whereupon a pin **87** may be inserted through the hinge or pivot arrangement at the other end or side of the semicircular portions of the outer sleeve **36***a* and inner bushing **35***a* for retaining them in position on the drill pipe section **16**.

It is to be noted that an inner bushing **35***a* which is formed by the two semicircular portions **83** and **84** includes the metal member **90** which is provided with a surfacing material thereon such as hard rubber or the like as illustrated at **91**. Fluid conducting means **27** are illustrated as being provided in the form of grooves **30** which are spaced circumferentially of each of the semicircular portions **83** and **84** of the inner bushing **35***a* for conducting fluid in a manner as described with regard to the FIGS. 2–4 modification of the invention. Similarly, serrations **53** are provided on the lower end of the semicircular metal portions **90** of the inner bushing **35***a* for engaging the upper surface of the tool joint when the pipe protector is reamed out, as previously described herein.

In order to place the form of the invention shown in FIGS. 5–7 inclusive on the drill pipe section, the hinge pin **87** will be removed whereupon the pipe protector **20***a* may be spread apart. It is to be noted that a longitudinal split **105** is formed in the outer sleeve **36***a* and mates with the longitudinal split **105***a* formed in the covering **91** on the inner bushing **35***a* and is axially aligned with the hinge portion formed in the metal portions **90** of the inner bushing **35***a* as shown in FIG. 6 of the drawings. After the device **20***a* is spread apart, it can be readily positioned about the drill pipe section **16** whereupon it may be closed and a pin **87** inserted through the hinge as illustrated in FIG. 6 of the drawings. This serves to retain the device **20***a* in position on the drill pipe section and yet provides a device which functions in a manner as previously described with the modification illustrated in FIGS. 2–4 of the drawings.

In FIGS. 8 and 9, still another form of the invention is illustrated generally by the numeral **20***b*, and in this form of the invention a modified hinge arrangement is provided for the metal semicircular portions **90***a*, as more clearly shown in FIG. 9 of the drawings. It is to be noted that the hinge arrangement, designated generally by the numeral **120**, is formed by cutting the sleeve in the manner as indicated along the line **121** which provides inner fitting portions which serve to retain or lock the metal semicircular portions **90***a* together, yet provides a means whereby they may be pivotally or hingedly connected together. In other respects, the form of the invention shown in FIGS. 8 and 9 is similar to that as described with regard to the FIGS. 5–7 modification. It will be noted that an outer sleeve **36***a* is provided which is formed of material such as hard rubber, metal, or plastic or other material which is softer than the drill pipe section or casing in which the device is to be used. Projections **22***a* are provided on the device which are separated by the recesses **23***a* to accommodate fluid flow exteriorly of the device and similarly fluid passage means **27***a* are provided on the interior of the inner bushing designated generally at **35***a* for accommodating fluid flow between the drill string and the device on which it is positioned. The initial positioning of the device illustrated in FIGS. 8 and 9 on the drill pipe section **16** is similar to that as described with regard to the modification shown in FIGS. 5–7 in that a split **105** is provided longitudinally of the outer sleeve **36***a*, there being a split **105***a* in the covering material provided on the semicircular portions of the inner bushing **35***a* as previously described with regard to FIG. 6 of the drawings. In the form of the invention illustrated in FIGS. 8 and 9, the outer sleeve **36***a* is not provided with a longitudinal slot conforming axially with the hinge **120**, nevertheless, the outer covering being formed of material such as hard rubber, will flex when the device is spread apart in a manner as described with regard to FIG. 6. After the device is spread apart, it may then be positioned around a drill pipe section **16** whereupon a hinge pin **87** may be inserted through the hinge formed at each edge of the semicircular portions **90***a*, respectively, whereupon the device is retained in position on the drill pipe section.

A particular advantage of a pipe protector of the form of the present invention is that the drill pipe may be more easily rotated than where the pipe protector is nonrotatably secured on the drill string.

It can be appreciated that other modifications of the present invention may be employed without departing from the scope of the invention, and the forms illustrated herein are for purposes of illustration only.

Broadly, the present invention relates to a pipe protector for tubular members, and more particularly, to an improved form of pipe protector adapted for use with drill pipe strings and other well strings.

What is claimed is:

1. A pipe protector for drill pipe sections which are adapted to be connected together by tool joints including,

(a) a tubular member for positioning on the drill pipe section, the inner diameter of said member being slightly greater than the outer diameter of the drill pipe section and smaller than the outer diameter of the tool joints when mounted thereon,

(b) fluid conducting passage means formed on the exterior surface of said member and fluid conducting passage means formed on the interior surface of said member for conducting fluid longitudinally of said interior and exterior surface of said member,

(c) said tubular member including an inner bushing split into a plurality of longitudinally extending sections,

(d) an outer sleeve extending coaxially with said inner bushing, and

(e) thread means on said sections for securing said inner bushing in said outer sleeve.

2. A pipe protector for drill pipe sections which are adapted to be connected together by tool joints including,

(a) a tubular member for positioning on the drill pipe section, the inner diameter of said member being slightly greater than the outer diameter of the drill

pipe section and smaller than the outer diameter of the tool joints when mounted thereon,

(b) fluid passage means for accommodating fluid flow around the drill pipe section on which the pipe protector is positioned,

(c) said tubular member including an inner bushing split longitudinally into a plurality of semicylindrical sections,

(d) an outer sleeve extending coaxially with said inner bushing, and

(e) thread means in said sections for securing said inner bushing in said outer sleeve.

3. A pipe protector for drill pipe sections which are adapted to be connected together by tool joints including,

(a) a tubular member for positioning on the drill pipe section, the inner diameter of said member being slightly greater than the outer diameter of the drill pipe section and smaller than the outer diameter of the tool joints when mounted thereon,

(b) fluid passage means for accommodating fluid flow around the drill pipe section on which the pipe protector is positioned,

(c) an annular outwardly directed taper on said interior surface at the lower end of said tubular member,

(d) said tubular member including an inner bushing split into a plurality of longitudinally extending sections,

(e) an outer sleeve extending coaxially with said inner bushing, and

(f) thread means on said sections for securing said inner bushing in said outer sleeve.

4. A pipe protector for drill pipe sections which are adapted to be connected together by tool joints including,

(a) a tubular member for positioning on the drill pipe section, the inner diameter of said member being slightly greater than the outer diameter of the drill pipe section and smaller than the outer diameter of the tool joints when mounted thereon,

(b) fluid passage means for accommodating fluid flow around the drill pipe section on which the pipe protector is positioned,

(c) an annular outwardly directed taper on said interior surface at the lower end of said tubular member,

(d) said tubular member including an inner bushing split longitudinally into a plurality of semicylindrical sections,

(e) an outer sleeve extending coaxially with said inner bushing, and

(f) thread means on said sections for securing said inner bushing in said outer sleeve.

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March 15, 1966 L. E. PENNINGTON ETAL 3,240,512

WEIGHT MEANS FOR UNDERWATER PIPE LINES

Original Filed Feb. 23, 1961 2 Sheets-Sheet 1

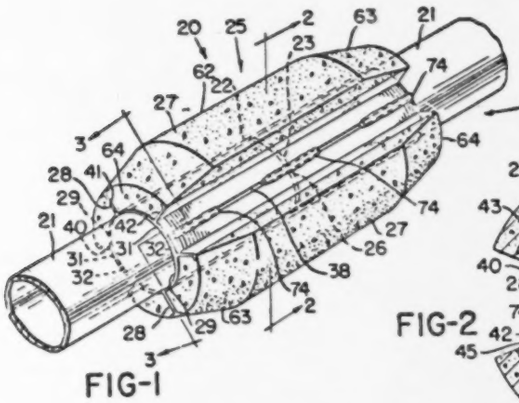


FIG-1

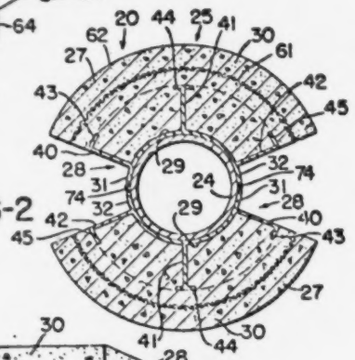


FIG-2

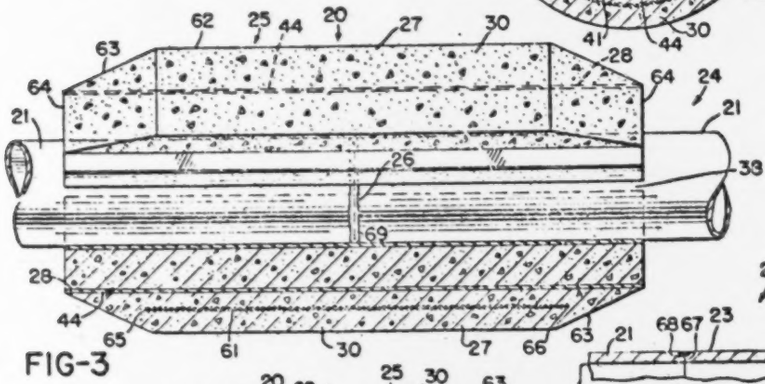


FIG-3

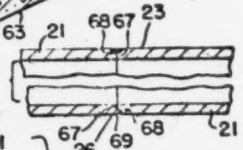


FIG-4

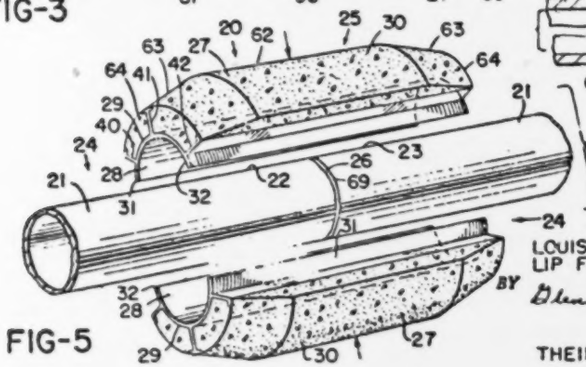


FIG-5

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WEIGHT MEANS FOR UNDERWATER PIPE LINES

Original Filed Feb. 23, 1961 2 Sheets-Sheet 2

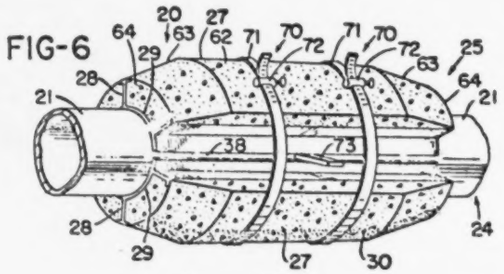


FIG-6

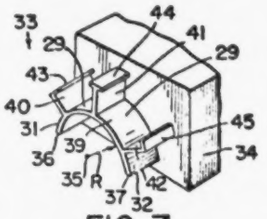


FIG-7

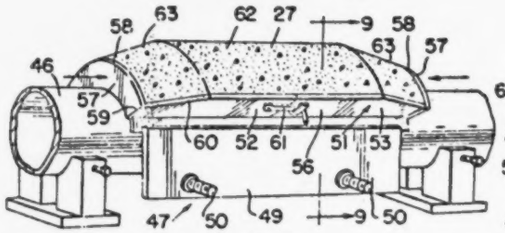


FIG-8

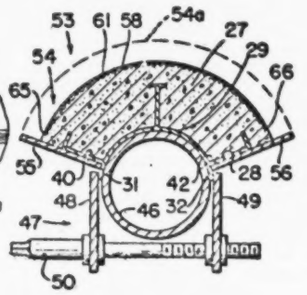


FIG-9

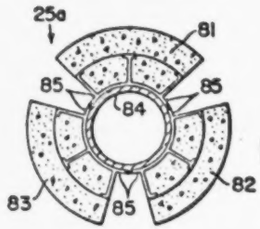


FIG-10

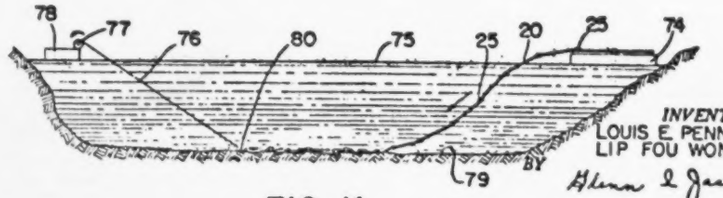


FIG-11

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3,240,512
WEIGHT MEANS FOR UNDERWATER PIPE LINES

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Continuation of application Ser. No. 91,206, Feb. 23, 1961. This application Oct. 26, 1964, Ser. No. 407,621

3 Claims. (Cl. 285—45)

This application is a continuation of Serial No. 91,206, filed February 23, 1961 and now abandoned.

This invention relates to improved conduit or pipe line constructions and to the methods of making the same or the like. This invention also relates to improved weights and/or couplers for forming such conduit constructions and to improved methods for making such weights or the like.

It is well known in the pipe line art that in order to lay pipes or conduits beneath bodies of water, such as lakes and the like for transporting oil, gas and the like across the body of water, the conduits or pipe lines are formed by butt-welding or otherwise securing together adjacent ends of adjacent conduit sections and thereafter sinking and anchoring such interconnected conduit sections to the bottom of the body of water by attaching weights to the interconnected conduit sections.

Such conduit or pipe line constructions are normally formed of steel whereas aluminum-containing metal is a more desirable material for such purpose because the same is light weigtht and non-corrosive. However, in the past, more time was required to install aluminum pipe lines than was required to install steel pipe lines. Further, aluminum pipe lines are more frequently damaged by boat anchors dragging near the bottom of the body of water because the joints of prior known aluminum pipe lines were deficient in strength and easily broken. Also, the weights attached to aluminum pipe lines readily fell off causing parts of the aluminum pipe line to float upwardly and be more susceptible to anchor grab and damage.

Accordingly, it is one of the features of this invention to provide improved methods and structures for joining together adjacent conduit sections and the like to provide improved conduit or pipe line constructions whether the same are made of aluminum-containing metal or other materials.

Another feature of this invention is to provide improved methods and structures for weighting such conduit or pipe line constructions whether the same are formed of aluminum-containing metal or other materials.

In particular, one conduit construction of this invention comprises a plurality of conduit sections having adjacent ends thereof secured together to form an elongated conduit and provide a plurality of peripheral seams along the length of the conduit. A plurality of weights are disposed along the conduit with each weight spanning a particular peripheral seam of the conduit and being secured directly to the adjacent pair of conduit sections defining that particular seam whereby the weights rigidify the seams of the conduit and weight said conduit. In this manner, a relatively rigid and durable conduit construction is provided which will be anchored by the weights against the bottom of a body of water.

Each weight of this particular conduit construction comprises a plurality of base means respectively carrying weight means, such as concrete and the like, and respectively having saddle portions disposed about the conduit and spanning the particular seam to be rigidified by the weight. Each saddle portion of each base means has a pair of opposed end flanges extending beyond the respective weight means thereof and being spaced from the end flanges of adjacent base means. Each end flange is secured directly to the conduit sections defining the seam spanned thereby and is also secured to an adjacent end flange of an adjacent base means whereby the interconnected base means rigidify that particular seam of the conduit and the weight means thereof weight the conduit to provide a negative buoyancy of the conduit.

Therefore, the weights of this invention not only provide improved joint structure for the particular conduit, but the same also are secured to the conduit in such a manner that the weights will not become detached therefrom as in prior-known constructions.

Accordingly, it is an object of this invention to provide an improved conduit construction having one or more of the novel features set forth above or hereinafter shown or described.

Another object of this invention is to provide an improved method for making such a conduit construction or the like.

A further object of this invention is to provide an improved weight and/or coupler for such a conduit construction or the like.

Another object of this invention is to provide an improved method for making such a weight or the like.

Other objects, uses and advantages of this invention are apparent from a reading of this description which proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIGURE 1 is a fragmentary, perspective view of one of the conduit constructions of this invention.

FIGURE 2 is an axial cross-sectional view of the conduit construction illustrated in FIGURE 1 and is taken on line 2—2 thereof.

FIGURE 3 is a side view of the conduit construction illustrated in FIGURE 1 and is taken on line 3—3 thereof to illustrate the same partially in elevation and partially in cross-section.

FIGURE 4 is a fragmentary, cross-sectional view illustrating one method for securing together adjacent ends of the adjacent conduit sections.

FIGURE 5 is a perspective view similar to FIGURE 1 and illustrates one of the initial steps in the method for securing the weight of this invention to the conduit construction of FIGURE 4.

FIGURE 6 is a view similar to FIGURE 5 and illustrates another step in the method for securing the weight of this invention to the conduit construction of FIGURE 4.

FIGURE 7 is a schematic, perspective view illustrating one of the methods for forming the base members of the weight of this invention.

FIGURE 8 is a perspective view illustrating one of the methods and apparatus for securing the weight means of this invention to one of the base members formed from the extruded stock illustrated in FIGURE 7.

FIGURE 9 is a cross-sectional view taken on line 9—9 of FIGURE 8 and illustrates one of the intermediate steps in the method of securing the weight means of this invention to one of the base members.

FIGURE 10 is a view similar to FIGURE 2 and illustrates another embodiment of this invention.

FIGURE 11 is a schematic view illustrating one method of laying one of the conduit constructions of this invention across the bottom of a body of water.

While the various features of this invention are hereinafter described as being particularly adaptable for forming conduit constructions from conduit sections formed of aluminum-containing metal or the like, it is

to be understood that the features of this invention are equally applicable to forming conduit constructions formed of any other desired material, such as steel and the like. Therefore, the features of this invention are not to be limited only to aluminum-containing conduit constructions.

Referring now to FIGURE 1, an improved conduit or pipe line construction of this invention is generally indicated by the reference numeral 20 and comprises a plurality of hollow conduit sections 21 secured together in aligned relation at adjacent ends 22 and 23 thereof to provide an elongated conduit 24 carrying a weight of this invention generally indicated by the reference numeral 25, the weight 25 not only weighting the conduit construction 20 to provide a negative buoyancy thereof, but also rigidifying the conduit peripheral seam 26 spanned thereby and defined by the secured ends 22 and 23 of the conduit sections 21.

Therefore, the weights 25 not only rigidify the seams or joints 26 of the conduit construction 20 in a manner hereinafter described, but the weights 25 also provide a negative buoyancy thereof and are secured thereto in a manner hereinafter described whereby the weights 25 are firmly fastened to the conduit 24 and cannot be readily dislodged therefrom whether the conduit sections 21 are formed of aluminum-containing metal or not.

Each weight 25 of this invention comprises one or more weight sections 27 secured to the conduit 24 and spanning a particular peripheral seam 26 thereof, the weights 25 of the conduit construction 20 including two weight sections 27.

Each weight section 27 comprises a metal base member or base means 28 having an arcuate saddle portion 29 for encompassing and engaging the conduit 24 on one side thereof and carrying suitable weight means 30 on the other side thereof. The saddle portion 29 has a pair of opposed end flanges 31 and 32 extending beyond the weight means 30 to be directly secured to the conduit 24 in a manner hereinafter described to permanently secure the weight section 27 to the conduit 24 to not only rigidify the particular peripheral seam 26 of the conduit 24 spanned by the weight section 27, but to also weight the conduit 24 to provide a negative buoyancy thereof.

The base members or means 28 can be formed of any suitable material and in any suitable manner, and, in the embodiment illustrated in the drawings, the base members 28 are respectively cut from a length of base member stock 33, FIGURE 7, formed of aluminum-containing metal and extruded by a conventional extruding apparatus 34 in a manner well known in the art.

The extruded stock 33 is extruded in such a manner that the arcuate saddle portion 29 thereof extends throughout the length thereof and is defined by a radius R generated about a point 35 spaced outwardly from a plane passing through the free ends 36 and 37 of the opposed end flanges 31 and 32 of the arcuate saddle portion 29. The radius R is of substantially the same length as a radius which will generate the outer peripheral surface of a particular conduit to be utilized with the stock 33 so that the concave side of saddle portions 29 of the base members 28 subsequently cut from the base member stock 33 will snugly encompass and engage the outer peripheral surface of the conduit utilized therewith.

Since the base member stock 33 is utilized to form the base members 28 of the weight 25 illustrated in FIGURES 1–9, wherein only two weight sections 27 are utilized to form the weight 25, the generating point 35 of the radius R defining the saddle portion 29 of the extruded base member stock 33 is only slightly spaced outwardly from the plane passing through the free ends 36 and 37 of the opposed end flanges 31 and 32 thereof. In this manner, the resulting base members 28 cut from the stock 33 and disposed about the conduit 22 in the opposed relation illustrated in FIGURES 1 and 2 will

have the adjacent pairs of opposed end flanges 31, 31 and 32, 32 thereof slightly spaced from each other to define a narrow longitudinal channel 38 therebetween for at purpose hereinafter described.

The convex side 39 of the saddle portion 29 of the extruded base member stock 33 has a plurality of reinforcing flanges 40, 41 and 42 extending outwardly therefrom and being integrally interconnected thereto. The reinforcing flanges 40–42 of the embodiment illustrated in the drawings are disposed substantially radially from the point 35 with the reinforcing flanges 40 and 42 being disposed inboard of the respective ends 36 and 37 of the end flanges 31 and 32 of the saddle portion 29, and the intermediate reinforcing flange 41 is disposed substantially equidistant between the outermost reinforcing flanges 40 and 42.

The reinforcing flanges 40–42 respectively carry integrally connected transverse webs 43, 44 and 45 at the outer ends thereof to provide tying means for the weight means 30 in a manner hereinafter described. The transverse webs 43 and 45 of the reinforcing flanges 40 and 42 extend only from the inboard sides thereof toward the intermediate reinforcing flange 41 to define L-shaped cross-sectional configurations whereas the transverse web 44 of the intermediate reinforcing flange 41 extends from both sides thereof to provide a substantially T-shaped cross-sectional configuration.

While the dimensions of the extruded base member stock 33 can vary as desired, it has been found that when the conduit sections 21 of the conduit construction 20 have an outside diameter of approximately 4.500 inches, the radius R generating the saddle portion 29 of the extruded base member stock 33 should be approximately 2.250 inches. The reinforcing flanges 40 and 42 are disposed at acute angles of approximately 22½° relative to a plane passing through the point 35 and disposed parallel to a plane passing through the ends 36 and 37 of the opposed end flanges 31 and 32 of the saddle portion 29 of the extruded base member stock 33, while the intermediate reinforcing flange 41 is disposed substantially perpendicularly to those planes. The reinforcing flanges 40–42 each has a length of approximately 2.000 inches, and the length of each transverse tying web 43–45 thereof is approximately 0.750 of an inch. While the thickness of the saddle portion 29 and flanges 40–42 can vary, it has been found satisfactory to form the same with a thickness of approximately 0.100 of an inch for this particular sized extruded base member stock 33.

After the base member stock 33 has been formed in the above manner, the individual base members or means 28 are cut therefrom in desired lengths. For example, when the conduit sections 21 have the joining ends 22 and 23 thereof provided with an outside diameter of approximately 4.500 inches and normally provided with a 4.000 inch inside diameter and hereinafter referred to as a four-inch conduit or pipe line section, the individual base members 28 have a length of approximately 24 inches.

After the base members 28 have been cut from the base member stock 33, each weight section 27 is formed therefrom in any desired manner, one such method and apparatus of this invention being illustrated in FIGURES 8 and 9.

In particular, each base member 28 has the saddle portion 29 thereof disposed over a supported mandrel 46 having substantially the same outside diameter as the particular conduit 24 to be utilized therewith. For example, the mandrel 46 can comprise a cut length of a conduit section 21, if desired. The opposed end flanges 31 and 32 of the base member 28 are firmly clamped or otherwise temporarily held against the outer peripheral surface of the mandrel 46 to hold the saddle portion 29 in its selected configuration during the weight means attaching operation. For example, the opposed end flanges

31 and 32 of the base means 28 are held in fixed relation against the outer peripheral surface of the mandrel 46 by a clamping device 47. The clamping device 47 comprises a pair of relatively movable jaws 48 and 49 carried by interconnecting means 50 which, when rotated in a particular direction, move the jaws 48 and 49 toward each other to compact the end flanges 31 and 32 of the base member 28 in stacked relation against the outer peripheral surface of the mandrel 46 to hold and maintain the saddle portion 29 of the base means 28 in the desired arcuate configuration.

After the base means 28 has been clamped to the mandrel 46 by the clamping device 47 or by any other suitable clamping device or holding means, a mold device 51 is interconnected to the base means 28 and comprises a pair of identical mold sections 52 and 53 respectively telescoped over the opposed ends of the base member 28 to define a mold chamber 54 with the convex surface 30 of the saddle portion 29 of the base member 28. Each mold section 52 and 53 includes a pair of outwardly directed and angularly disposed side boards 55 and 56 interconnected at one end thereof by an end plate 57, the side boards 55 and 56 being adapted to be disposed in sliding relation with the outboard sides of the reinforcing flanges 40 and 42 of the base member 28 in the manner illustrated in FIGURE 9 with the end plate 57 thereof disposed flush against the respective ends of the reinforcing flanges 40–42 and the saddle portion 29. The end plate 57 has the top surface 58 thereof arcuately shaped and extending to the transverse webs 43–45 of the reinforcing flanges 40–42. The end edges of the side boards 55 and 56 of each mold section 52 and 53 is divided into two portions in the manner illustrated in FIGURE 8 whereby the lower portions 59 thereof are disposed substantially perpendicularly to the mandrel 46 with the outer portions 60 thereof sloping backwardly toward the other mold section 52 or 53 at a desired angle for a purpose hereinafter described. The assembled mold sections 52 and 53 can be interconnected about the base member 28 by suitable fastening means 91 to hold the same in the position illustrated in FIGURE 8 and can have the inside surfaces thereof lined or coated with suitable material which will resist any tendency for the weight means 30 cast therein from being secured thereto. Alternately, the entire mold device 51 can be formed of such nonadhering material, if desired.

After the molding device 51 has been secured to the clamped base member 28 in the above manner, suitable weight material 30, such as concrete or the like, is poured into the mold chamber 54 thereof in the manner illustrated in FIGURE 9 to a desired height whereby an arcuately-shaped reinforcing member 61 is placed thereon. Thereafter, additional mold material 30 is poured on top of the reinforcing member 61 until the cavity 54 is completely filled with the weight material 30 to the level of the dotted line 54a in FIGURE 9. The non-set weight material 30 is subsequently troweled or otherwise suitably formed to provide an outer arcuate surface 62 having beveled end portions 63 in the manner illustrated in FIGURE 8, the edges 58 of the end plates 57 and the edge portions 60 of the side boards 55 and 56 defining part of the perimeters of the beveled ends 63 of the weight material 30.

After the mold material 30 has hardened and become firmly secured to the base member 28 and tied thereto by the tying webs 43–45, the clamping device 47 and mold device 51 are removed from the base member 28 whereby a particular weight section 27 has been completely formed.

It has been found desirable to clamp the base member 28 of each weight section 27 to the mandrel 46 or other suitable structure during such weight casting operation in order to assure that the saddle portion 29 thereof will have a desired cross-sectional configuration after the mold material 30 has set and hardened. However, it is to be

understood that the mold material 30 may be cast to the base member 28 before the same is clamped to the mandrel 46 as long as the base member 28 is clamped thereto before the weight material 30 sets and tends to permanently draw the saddle portion 29 out of its selected configuration.

While the weight material 30 can be formed of any desired material, it has been found that a concrete having a high density, heavy aggregate grout with a density in the order of 205–215 per cubic foot performs satisfactorily. Such concrete is known commercially as "Barite."

While the particular shape and size of the weight means 30 of each weight section 27 can vary as desired, it has been found that when the particular weight section 27 is being utilized with the afore-mentioned four-inch conduit 24, the arcuate outer peripheral surface 62 can extend approximately 3.750 inches above the saddle portion 29. The weight means 30 has a minimum bumper shoulder 64, FIGURE 1, of approximately 0.750 of an inch and beveled end portions 63 disposed at angles of at least 25° relative to the outer arcuate surface 62 thereof.

The reinforcement 61 can be formed of any suitable material, and, in the embodiment illustrated in the drawings, the reinforcing member 61 comprises a two-inch by #10 gauge steel reinforcing mesh previously bent into arcuate form and preferably located at a minimum of 1½ inches below the outside concrete surfaces at all points of the weight means 30 and, preferably, not over two inches therefrom. Preferably, the reinforcing member 61 extends the entire length of the weight means 30 to within 1½ inches of either end thereof. While the ends 65 and 66 of the reinforcing member 61 illustrated in FIGURE 9 do not extend to the side boards 55 and 56 of the molding device 51, it is to be understood that the same can extend thereto so as to be disposed in the position illustrated in FIGURE 2 when a particular weight section 27 is formed therefrom in the above manner.

Each weight section 27 is formed in the above manner either at the location of the conduit laying operation or remote therefrom and shipped to the conduit laying location to be subsequently interconnected to the conduit 24 in a manner hereinafter described.

While the elongated conduit 24 can be formed from a plurality of conduit sections 21 formed in any suitable manner, it is preferred to utilize heavy ended aluminum-containing conduit sections each having a length of approximately forty feet. For example, it is well known in the conduit and pipe line art that conduit sections are provided commercially having thickened walls at the opposed ends thereof whereas the major portion of the conduit sections have relatively thin walls whereby the heavy ends thereof can provide joint structures of desired strengths without requiring that the entire length of the conduit sections be provided with a wall thickness corresponding to the ends thereof. Therefore, a savings in material of approximately 27% is provided by heavy end pipes or conduit sections over conventional conduit sections having uniform wall thickness throughout their entire lengths.

A typical four-inch, forthy-foot heavy end conduit section 21 formed of 6061–T6, 6062–T6 or 5083–H112 aluminum alloy has heavy ends of approximately 11 inches long and a wall thickness of approximately 0.237 of an inch whereas the major portion of the conduit section has a wall thicknes of approximately 0.163 of an inch.

The elongated conduit 24 is formed by serially interconnecting adjacent ends of adjacent conduit sections 21 together in aligned relation, the conduit sections 21 being the afore-mentioned heavy end aluminum-containing conduit sections or conventional conduit sections formed of steel, aluminum or the like, as desired.

In particular, each end 22 and 23 of the conduit sections 21 is formed with inwardly disposed flat land 67 and an outwardly disposed beveled surface 68, the conduit

sections 21 either being originally provided with the lands 67 and beveled surfaces 68 or having the same formed in a manner well known in the art at the conduit forming and laying location. The lands 67 of adjacent ends 22 and 23 of adjacent conduit sections 21 abut each other in the manner illustrated in FIGURE 4 and the ends 22 and 23 are secured together by a weld 69 that interconnects the beveled surfaces 68 together and has the outer surface thereof disposed flush with the outer surface of the conduit sections 21 to define the peripheral seam 26 previously mentioned.

No crown reinforcement of the weld 69 is provided because any bending and tensile stresses across the butt welded seam 26 is borne by the weight 25 spanning the same in a manner hereinafter described.

When the aforementioned four-inch conduit sections 21 are utilized, it has been found that the flat lands 67 thereof should be approximately 3/16 of an inch, with the beveled surfaces 68 thereof disposed at an angle of approximately 45° relative to the lands 67 when the weld 69 is formed by automatic welding machinery which normally requires a maximum of three passes around the four-inch pipe. It has been found, however, that the beveled surfaces 68 should be disposed at approximately 60° relative to the lands 67 when the weld 69 is formed by hand, using the inert gas shield metal arc welding method well known in the art.

After the adjacent ends 22 and 23 of adjacent conduit sections 21 have been welded together, in the manner illustrated in FIGURE 4, a pair of weight sections 27 are disposed about the resulting conduit 24 in the manner illustrated in FIGURE 5 whereby the saddle portions 29 thereof span the well seam 26 of the conduit 24 and are disposed oppositely relative to each other. Preferably, the weight sections 27 are clamped to the conduit 24 in the manner illustrated in FIGURE 6 to assure a close fit between the saddle portions 29 of the weight sections 27 and the outer peripheral surface of the conduit 24. Such clamps can comprise the conventional come-along clamps 70 each having an elongated strap 71 looped about the weight sections 27 and being progressively tightened therearound by suitable fastening means 72 either manually or hydraulically in a manner will known in the art to hold the weight sections 27 in intimate contact with the conduit 24 during the subsequent weight securing operation. However, it is obvious that other types of clamping means or holding devices can be utilized for this purpose, if desired.

During the clamping operation of the weight sections 27 to the conduit 24, suitable gapping tools 73 can be utilized to assure the proper spacing 38 between adjacent end flanges 31, 32 and 31, 32 of the weight sections 27 to permit the adjacent pair of end flanges 31, 32 and 32, 32 not only to be secured to each other but also to the conduit 24 in the following manner.

The clamping means 70 are so arranged relative to the weight sections 27 that each end flange 31 and 32 thereof can be welded directly to the conduit sections 21 of the conduit 24 and to the adjacent end flange 31 or 32 of the adjacent weight section 27 by a plurality of longitudinally disposed skip welds 74 in the manner illustrated in FIGURES 1 and 2. Preferably, two groups of three skip welds 74 are utilized when the weight sections 27 are being interconnected to the afore-mentioned four-inch conduit sections, each skip weld 74 being approximately four to five inches long with one of the skip welds 74 of each group thereof crossing the weld seam 26 of the conduit 24.

Preferably, the weight sections 27 are secured to the conduit 24 by the clamping means 70 with one weight section 27 disposed vertically over the other weight section 27 so that the welding operator can approach both pairs of opposed end flanges 31, 32 and 31, 32 to effect the welding operation thereof without turning the conduit 24.

By welding or otherwise securing each base member 28 of the weight 25 directly to the conduit 24, as well as to the other base member 28 thereof, the weight 25 formed thereby cannot shift axially along the conduit 24 in the manner provided by the prior-known weight constructions. Further, since the base members 28 of the weight 25 span the peripheral seam 26 thereof, the weight 25 rigidifies the seam 26 to provide an improved conduit joint not provided by prior-known instructions.

For example, it has been found that when the conduit construction 20 is formed of a plurality of aluminum-containing conduit sections 21, the weights 25 are not only adequately secured thereto so that the same will not fall off as in prior-known constructions, but also the weights strengthen the conduit joints 26 in such a manner that the resulting conduit construction 20 is far superior to prior-known conduit constructions even when the same are formed of steel and the like.

In particular, in a long-string pick-up test in which 300-foot strings of aluminum conduit sections interconnected by the weights of this invention and a 300-foot string of butt welded steel pipe were picked up simultaneously, failure of the steel pipe occurred in cracking of the weld bead at a 57-foot elevation whereas the aluminum conduit construction failed in buckling of the conduit section at 61 feet when the aluminum pipe was formed of aluminum alloy 6061–T6 and at 79 feet when the pipe was formed of aluminum alloy 5083–H112. Thus, when forming an aluminum conduit or pipe line construction according to the teachings of this invention, the conduit itself failed bfeore the joints thereof.

In jib-binding tests, in which a back-breaking load was applied to the pipe joint across a 40-foot span with end hold-down rollers, all aluminum pipe failures occurred at points other than at the pipe joint which was located at the mid-span thereof.

In a direct tension test, the butt weld seam 26 of a conduit construction 20 formed of aluminum alloy 6061–T6 heavy end pipe failed at 131,900 pounds tension. However, since the computed tensile breaking load of the thinner wall of the conduit body is only 117,000 pounds in direct tension, the weight-reinforced butt welded seam 26 exceeds that of the pipe body itself thereby eliminating the joints of the conduit construction 20 from consideration in tension as well as in bending computation.

There is also evidence that the weights 25 improve the bursting pressure of the butt weld seams 26.

Accordingly, it can be seen that the methods and structures of this invention overcome the prior known disadvantages of utilizing aluminum-containing metal conduits for pipe line or conduit constructions that are to be disposed across the bottom of a body of water, the methods and structures of this invention not only increasing the strength of the joints of the conduits for pipe lines, but the same also adequately secures the weighting medium thereto in such a manner that the weights cannot shift axially relative to the conduit and cannot be accidentally dislodged therefrom to permit part of the pipeline to float upwardly and be subject to damage by anchorage dragging and the like, as in prior-known constructions.

While the conduit construction 20 may be formed in any desired sequence during the laying operation thereof, two such methods have been tested and proved adequate, whereas it is obvious that other methods may be also utilized.

For example, as illustrated in FIGURE 11, the conduit construction 20 is formed on a barge 74 or the like, anchored on the particular body of water 75 at one of the terminal points of the pipe line or conduit construction. As each conduit section 21 is secured to the pipe line construction 20, a weight 25 is secured thereto at the resulting seam 26, and, thereafter, the conduit construction 20 is pulled toward the other terminal point of the pipe line by a cable 76 of a winch 77 caried on another barge 78 anchored at that terminal point of the conduit construc-

tion 20. As the conduit construction 20 is drawn from the conduit construction-forming barge 74, additional conduit sections 21 are secured thereto, together with the interconnected weights 25, so that the conduit construction 20 is progessively drawn across the bottom 79 of the body of water 75 by the winch 77. The end 80 of the conduit construction 20 is closed by suitable flanging means before the dragging operation thereof across the bottom 79 of the body of water 75 and the streamlined configuration of the individual weight sections 27, provided by the flat ends 64 and beveled surfaces 63 thereof, permit the weights 25 to be dragged across the bottom 80 of the body of water 75 without spalling or otherwise cracking of the cement weights 30 thereof.

An alternate method of forming the pipe line construction 20 would be to form various lengths thereof on land and, thereafter, tow the same out into the body of water and interconnect those lengths together to form the conduit construction 20 across the body of water 75.

While the conduit construction 20 is illustrated as having the weights 25 thereof secured solely at the joints 26 of the conduit 24, it is to be understood that the weights 25 could also be secured along the conduit 24 at places other than at the seams 26 thereof to perform solely the weighting function. However, when the weights 25 are secured to the seams 26 of the conduit 24, the weights 25 not only provide negative buoyancy for the conduit 22 but also reinforce the seams 26 in the manner previously described.

While the weights 25 have been illustrated as being formed of a pair of weight sections 27, it is to be understood that a single weight section 27 can be utilized, if desired. Further, more than two weight sections 27 can be utilized to form the weight 25 in the manner illustrated in FIGURE 10.

In particular, the weight 25*a* comprises three weight sections 81, 82, and 83 secured to a conduit 84, either at the seam thereof or anywhere along the length thereof. Each weight section 81, 82, or 83 has each opposed end flange 85 of the saddle portion thereof secured directly to the conduit 84 and to an adjacent end flange 85 of an adjacent weight section in the same manner as the weight 25 previously described.

Therefore, one or more weight sections can be utilized to form the weights of this invention.

Since it has been found that a dry weight of 165 pounds must be provided for each forty-foot length of the aforementioned four-inch heavy end aluminum conduit sections 21 to provide a 5% negative buoyancy for the evacuated conduit construction 20, the weights 25 or 25*a* for each peripheral seam 26 thereof must weight at least 165 pounds whether formed of one or more weight sections. However, if the weights 25 or 25*a* do not weight 165 pounds, additional weight sections can be attached to the conduit construction 20 at points other than the seams 26 thereof to provide the desired degree of negative buoyancy, and this invention is not to be limited to any particular weight for each weight section thereof, as the length of the conduit sections 21 or weight sections can vary, as desired.

Accordingly, it can be seen that this invention provides an improved conduit or pipe line construction as well as an improved method of making the same or the like. Further, this invention provides an improved weight or coupler for such a conduit construction or the like as well as an improved method of making such a weight or the like.

What is claimed is:

1. In combination, a metal conduit having an outer peripheral surface, and a plurality of opposed metal base means respectively carrying concrete weights to weight said conduit and respectively having saddle portions encompassing and engaging part of said peripheral surface of said conduit, said saddle portions of said base means each having a pair of opposed end flanges extending beyond said weight thereof and being spaced from adjacent end flanges of adjacent base means, each end flange of each base means being secured by welding directly to said conduit and to the adjacent flange of an adjacent base means, said saddle portions of said base means each having outwardly directed longitudinal flanges disposed inboard of said end flanges and confining said weight therebetween at an area removed from the area of the weld whereby said concrete weights are removed from the heat of the weld.

2. In combination, a conduit having an outer peripheral surface, and a plurality of base means respectively carrying weight means to weight said conduit and respectively having saddle portions encompassing and engaging part of said peripheral surface of said conduit, said saddle portions of said base means each having a pair of opposed end flanges extending beyond said weight means thereof and being spaced from adjacent end flanges of adjacent base means, each of said end flanges being secured by welding directly to said conduit and to the adjacent flange of an adjacent base means, said saddle portions of said base means each having outwardly directed longitudinal flanges disposed inboard of said end flanges and confining said weight therebetween at an area removed from the area of the weld whereby said weight means are removed from the heat of the weld.

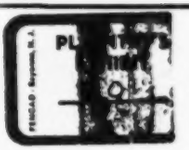
3. In combination, a conduit having an outer peripheral surface and including a pair of sections secured together at adjacent ends thereof to provide a peripheral seam of said conduit, and a plurality of base means respectively carrying weight means to weight said conduit and respectively having saddle portions encompassing and engaging part of said peripheral surface of said conduit and spanning said seam thereof, said saddle portions of said base means each having a pair of opposed end flanges extending beyond said weight means thereof and being spaced from adjacent end flanges of adjacent base means, each of said end flanges being secured by welding directly to said conduit and to the adjacent end flange of an adjacent base means, said saddle portions of said base means each having outwardly directed longitudinal flanges disposed inboard of said end flanges and confining said weight means therebetween at an area removed from the area of the weld whereby said weight means are removed from the heat of the weld.

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Modern Approach to Cathodic Protection of Offshore Pipelines

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CATHODIC PROTECTION SERVICE
Houston, Texas

Modern Approach to Cathodic Protection of Offshore Pipelines

by Gordon L. Doremus and Jack G. Davis
Cathodic Protection Service

Sea water is probably the most corrosive of all natural environments in which pipelines are laid deliberately. After the lines are in place they are virtually inaccessible, and repairs for any reason are expensive, as might be anticipated from line construction costs. A recently published comparison of the cost of offshore pipelines versus onshore lines indicates that it is more expensive to lay a 12-in. gas transmission line offshore than a 30-in. line onshore.

Recently, the critical aspect of pollution from oil or product leaks, not to mention product loss, has been brought vividly to the attention of the general public and to the pipeline operators as well.

These factors point to the importance and, in truth, the absolute economic necessity of effective corrosion prevention measures on offshore pipelines. Possibly only in the matter of public safety are onshore lines more critically in need of such corrosion control measures. Cathodic protection is a vital tool in the maintenance of corrosion-free pipelines, both offshore and onshore. Cathodic protection offshore, like pipeline construction, is more expensive and must be approached in a slightly different manner.

Offshore pipelines are, of course, the arteries of the offshore oil and gas fields. Most primary offshore lines are well constructed with superior dielectric coatings for corrosion prevention and an overlay of concrete which affords the required negative buoyancy and excellent mechanical protection for the coating. These mechanical and electrical barriers must be supplemented with cathodic protection for complete corrosion mitigation and long trouble-free pipeline life.

Cathodic protection is accomplished by the application of a direct electrical current from an outside source, flowing through the corroding electrolyte to the structure to be protected. The current discharge source is the "anode"

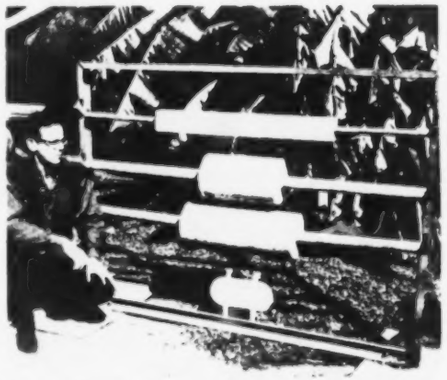


Fig. 1. Various sizes and shapes of zinc anodes for marine service.



Fig. 2. Segmented type zinc bracelets on pipeline joints.

and the structure receiving current is the "cathode". When the cathode density reaches a certain level, typical for a given corrosive environment, corrosion of the cathode stops completely. It is the duty of the corrosion engineer to ascertain what the necessary level of current density is for a given offshore pipeline and design a cathodic protection system capable of providing this current for many years.

Two Sources of Current

There are two common sources of this protective current, both of which are in wide use on offshore pipelines today. One is the galvanic anode, a metal or alloy that by nature of its position in the Electromotive Series of Metals is anodic to, and will corrode and discharge electric current to protect, the more noble metal cathode. For protection of steel, suitable galvanic anodes are made of magnesium, zinc and aluminum, all alloyed to produce continuous protective current at the highest possible current efficiency, i.e., amphere hours of protective current per pound of metal consumed.

Table 1 shows a comparison of performance characteristics and costs between these three

Table 1. Comparison of Magnesium, Zinc and Aluminum Sea Water Anodes

Anode material	Open circuit potential, Volts-Ag/AgCl	Energy output, Amp-hr/lb	Current efficiency, %	Consumption, Lb/amp-yr	Cost, Amp-yr
Mg	-1.50	500	50	17.5	$7.53
Zn	-1.05	354	95	24.8	$6.20
Al	-1.05	1280	95	6.8	$3.77

galvanic anodes. At present, zinc and magnesium are most widely utilized for offshore pipeline cathodic protection systems because of their proven satisfactory performance in the mud on the ocean floor. The aluminum alloy anode listed in Table 1 is the best of several proprietory anodes presently on the market, none of which are suitable for burial in the mud.

Fig. 1 shows various sizes and shapes of conventional zinc anodes for marine service, and Fig. 2 illustrates a segmented type zinc "bracelet anode, which has become popular for long range protection of offshore pipelines in the last five years. Magnesium anode use is limited to short-life cathodic protection systems, or to special cases where the anodes can be readily replaced, due to the highly active nature of this anode.

The other source of cathodic protection current is derived from conversion of a-c power to

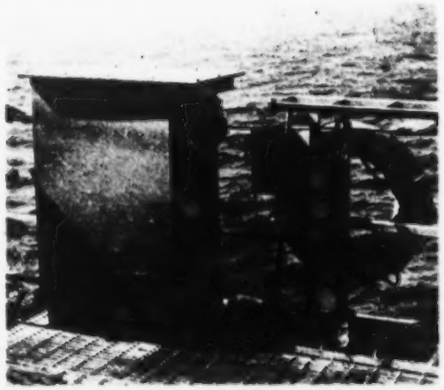


Fig. 3. Rectifier on an offshore platform for CP on a gas line.

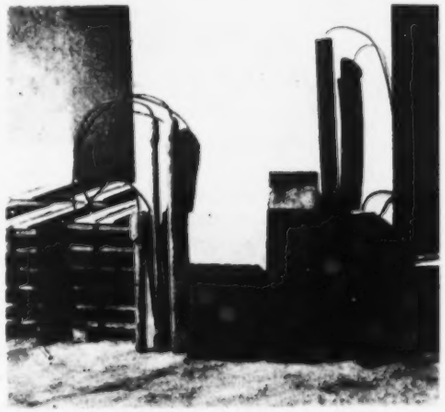


Fig. 4. Conventional graphite and silicon-iron anodes for CP applications offshore.

d-c by means of a rectifier. The d-c power is then introduced to the electrolyte by means of semi-inert long life anodes such as linseed oil treated graphite, high silicon cast-iron, or lead-silver alloy.

Fig. 3 is a view of a rectifier on an offshore platform for cathodic protection of a gas line from the platform to shore. Fig. 4 shows various types of conventional graphite and silicon-iron anodes utilized for offshore application. Fig. 5 shows a 3-in. by 30-in. lead-silver-antimony alloy anode and a winch-davit assembly developed for cathodic protection of offshore pipelines and platforms.

New Anode Designs

Troubles with diver-installed conventional graphite anode and silicon iron beds and underwater splices, plus the need for "high current capacity" anodes in some areas, have led to

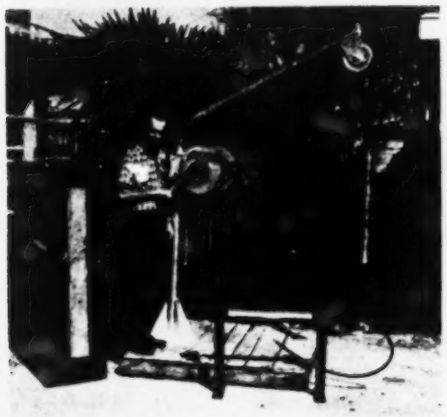


Fig. 5. 3-in. by 30-in. lead-silver alloy anode and winch-davit assembly.



Fig. 6. 4500-lb graphite anode packaged in 30-in. pipe.

utilization recently of two anode designs: (1) large cylindrical graphite anodes (4500 lb) packaged in large diameter pipes, as shown in Fig. 6, and 2) lead-silver alloy anode "sleds", as shown in Fig. 7.

Selecting the Right System

Both types of cathodic protection systems, galvanic anodes and impressed current, accomplish the same objective, and the selection is in final analysis based on overall economics, electric power availability, and maintenance considerations. For satisfactory results it is imperative that the cathodic protection system supply protective current continuously. Therefore, when designing or purchasing a cathodic protection system for offshore pipelines, it is well to pay heed to the slogan "System Simplicity Lends to System Reliability".[2]

The type and capacity of cathodic protection system selected is also influenced by the size, length, location and type of construction of the offshore pipeline or pipeline complex. A new offshore gas gathering and transmission pipeline system in the Louisiana area consists of 65 miles of 36-in. main line from an onshore delivery point to a central gathering point offshore. From this point there are 35 miles of 30-in. line, 23 miles of 26-in. and a total of 46.5 miles of 24-in. to gather gas from various fields. There are five template type offshore platforms involved in the complex. These structures are used for tie-ins to the sales delivery lines and are normally unmanned, without permanent power and a minimum amount of maintenance activity.

The pipelines in this new complex have a superior dielectric coating with a concrete overlay and are buried below the mud line. The cathodic protection system consists entirely of zinc bracelets designed to fit flush with the pipe's concrete coating and to afford cathodic protection for 40 years. In this instance the platforms are also protected with galvanic aluminum alloy anodes sizes for 20-year replacement life. Therefore, for all intents and purposes the cathodic protection system is maintenance-free except for routine checks to assure continued satisfactory performance of the anodes per design.

By contrast, some offshore lines are shorter and leave directly from an offshore production platform which is manned with adequate and continuous electric power available. Several of these lines are protected with impressed current systems located at the platform. For optimum protective current spread the anode bed is laid out a considerable distance from the platform and pipeline. For ease of installation a large graphite anode, as described above, is a popular choice. A winch-davit suspended lead-silver anode on the platform itself is frequently used when current requirements for the pipeline are moderate. The rectifier type system requires at least weekly monitoring to assure continuous satisfactory operation.

Design Problems

The design problems associated with cathodic protection on offshore lines are similar to those for onshore lines, the principal exception being limited accessibility of the line for checking, inspecting or installing cathodic protection once the line is laid. The condition of the coating "in place" is usually excellent due to the mechanical protection afforded by the concrete jacket.

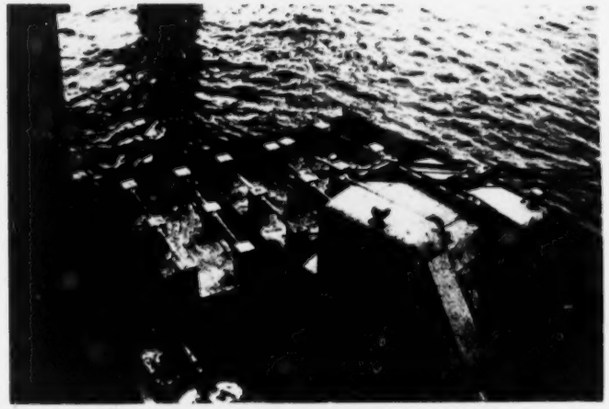


Fig. 7. Lead-silver alloy anode "sleds".

Another problem worth considering is the fact that not all pipelines offshore are buried, and the coatings may be subjected to marine organism attack, which can cause extensive or even complete coating failure with time where concrete cover is not used. Also, "buried" lines actually may be above the bottom in places or uncovered by shifting bottom conditions. They are thus subject to accelerated corrosion due to differences in electrolyte resistivity if they are not protected adequately.

For very long lines the protective current attenuation with increasing distance from the current source becomes an important problem, even with good coatings and substantial pipe wall thickness. If the coating resistance is too low, then it may be impossible to obtain cathodic protection at the far end of the line (opposite the cathodic protection installation) without raising the potentials of the line to values that may damage the dielectric coating.

Another troublesome problem on some offshore lines is attaining and maintaining electrical insulation of the pipeline from the offshore platforms. Short lines, such as coated flow lines, purposely are made electrically common with the platforms and receive cathodic protection from the platform system. Primary pipelines, however, usually employ their own cathodic protection system and therefore must be electrically isolated from the platforms by means of special insulating flanges or similar devices, usually installed on the riser piping.

As previously noted, a-c power required for impressed current systems is not always avail-

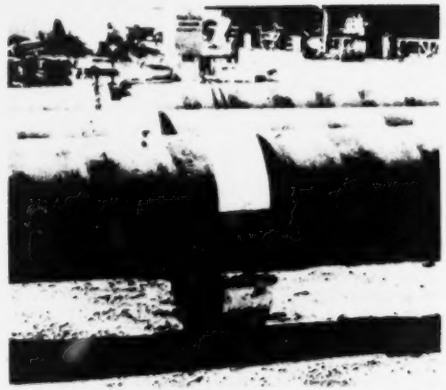


Fig. 8. New type zinc bracelet—solid semi-cylindrical segments.

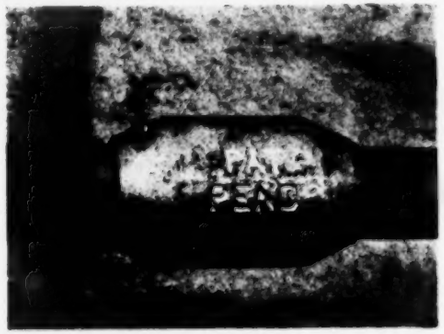


Fig. 9. Tapered semi-cylindrical zinc bracelet for small diameter pipelines without concrete weight coat.

able offshore, or, if it is, it may be only on a part time basis. The dependability of power offshore is not nearly so high as one may expect onshore.

What About Maintenance?

Another problem encountered with cathodic protection offshore is maintenance, or lack of it. It is an inescapable fact that cathodic protection systems offshore typically are not monitored or maintained as well as they would be onshore.

The selection and locations of the cathodic protection current source or sources, i.e., galvanic or impressed current, are influenced by the problems and factors discussed.

Present trends seem to be toward the maintenance-free galvanic anode approach for cathodic protection on offshore pipelines. Also, as the pipelines go farther offshore the problem of attenuation, as noted earlier, tends to eliminate the consideration of impressed current cathodic protection systems because normally they can only be located at the extremities of the line. Such situations also pose an inherent difficulty as to how the pipe potential, which is the basis of adequate cathodic protection, can be measured or estimated in the middle portion of a long run with current applied at each end.

Recent improvements in the zinc bracelet design, such as the availability of solid semi-cylindrical segments instead of the old multi-segmented type, have made this approach to cathodic protection even more popular in 1969 for major offshore pipeline projects. The new type bracelet is shown in Fig. 8. The advantages over the old type are economy, ease of installation at the pipe coating yard and better fit. Furthermore, the circumferential steel core is inside the anode material instead of outside, and there is much less exposed core to demand protective current.

Costs

The cost of cathodic protection with this type zinc bracelet for a 26-in. pipeline is $1600 per mile for a 40-year bracelet life. This amounts to $40 per mile per year. And compares quite favorably with $100 per mile per year (power costs included) for an impressed current system on 20 miles of 26-in. line recently reported by an offshore operator. Looking at it another way, the cost of the bracelet type cathodic protection system is approximately ½ of 1% of the cost of the pipeline for 40 years of cathodic protection.

For small diameter lines, with no concrete coating, a tapered semi-cylindrical bracelet such as shown in Fig. 9 should be used to avoid problems with the rollers on the pipe lay barge.

What's Ahead

In the future the trend to unattended maintenance-free cathodic protection systems should continue. There is every reason to believe that further development and testing will lead to early availability of an aluminum alloy suitable for pipeline bracelets and more economical than zinc. Aluminum alloy bracelets would exhibit 50% gain in anode life for the same shape if 95% efficiency[3], which is now attained by the best available aluminum alloy anode in straight sea water service, (see Table), can be maintained in the saline mud electrolyte. This would further reduce the cost of cathodic protection by yielding a longer life cathodic protection system for a given size and shape of bracelet. ■

References

[1] John P. O'Donnell. "Pipeline Installation and Equipment Costs." *Oil & Gas Journal*, August 1969, pp. 145-154.

[2] W. B. Colvin. "A Challenge To Corrosion Control. Offshore Structures," *Petroleum Engineer*, October 1967.

[3] C. F. Schrieber and J. T. Reading. "Field Testing A New Aluminum Anode." *Materials Protection*, Vol. 6 No. 5, May 1967.

About the Authors



G. L. Doremus



J. G. Davis

Gordon L. Doremus is supervisor of technical and field engineering activities for Cathodic Protection Service, Houston, Tex. He is a graduate of Tulane University with BS and MS degrees. After graduation, he served as a research chemist with the U.S. Department of Agriculture in New Orleans for five years. He then joined Cathodic Protection Service and in 1953 became a partner in the firm. He is the author of several papers in the cathodic protection field, and he is a member of NACE, ACS and the American Society for Oceanography.

Jack G. Davis is senior corrosion engineer for Cathodic Protection Service. He has done extensive work in design and installation of cathodic protection systems for offshore platforms, oil and gas transmission lines, industrial plants, and underground facilities for various municipalities. He has a BS in mechanical engineering from the University of Texas. Before joining Cathodic Protection Service in 1954, he was with Transcontinental Gas Pipe Line Corp. He is a registered professional engineer and an active member of NACE, ASME and TSPE.

Mr. G. W. Kurr

HOUSTON OFFICE

9210 MARKET STREET ROAD

P O Box 24093 Ph OR 4-7611

May 21, 1969

FILE MEMO:

ZINC BRACELETS

The following is intended to outline the present situation on zinc bracelets.

When Cathodic Protection Service initially bolted from the family, they obtained a sizeable quantity of business--perhaps 10 tons--a good part of it in the form of the one-half circles they are promoting. Since that time, however, we have managed to share all of the business with one exception, although at reduced margins. Most of this has been done through Oilfield Corrosion who are willing to go all out to maintain a position in this market.

Recently, however, there was an inquiry for approximately 70,000 pounds on which Oilfield did not get an opportunity to quote. In this case France Foundry got an opportunity but, in our opinion, did not assess the competitive situation properly even though we had given them what we felt was a most competitive price. As a result, they lost the business to CPS.

At the present time there is an open order for approximately 315,000 pounds which we understand is to be divided between CPS and France Foundry. The France Foundry portion which we will receive is 235,000 pounds. We understand that CPS will furnish their portion in the new one-half circle. This seems odd in that it appears they are actively going after smaller sizes. It is possible they are building information for their patent application. The order in question is to be placed Wednesday evening or Thursday morning. We will be on needles and pins until it is actually in the house.

Through one of our distributors, we have obtained several photographs of the CPS-Standard Brass product, but we have not yet been able to determine just what process is being used to produce it. A sample was on display in town this week, but most of the surface was covered with epoxy, and the remaining surface had a strange appearance not at all like what you might find in permanent mold.

Cont'd

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HOUSTON OFFICE

9200 MARKET STREET ROAD

P. O. Box 24038 Ph. OR 4-7611

FILE MEMO: -2- MAY 21, 1969

Mr. Baxter is to be in New Orleans today, and we have arranged for him to get an opportunity to go through the pipe yard and examine some of these segments closely. We are hopeful that we will have a better idea of the manufacturing procedures when Mr. Baxter returns.

E. J. Baker

EJB/rb

cc: Messrs. R. A. Kenkel
G. W. Kurr

APPENDIX F

Table 1

ALL CIRCUIT COURTS OF APPEALS
Compiled From Cases Reported In
United States Patent Quarterly Jan. 1969 to Aug. 1979

Year Reported	Total No. of Patents Adjudicated	Valid and Infringed %	Invalid %	Valid but not Infringed %	Valid, but Infringement issue not reached %
1969	51	11.7	66.7	19.6	2.0
1970	43	23.3	72.1	4.6	0
1971	72	18.1	62.5	9.7	9.7
1972	41	29.3	61.0	7.3	2.4
1973	51	25.5	45.1	19.6	9.8
1974	43	23.3	72.1	4.6	0
1975	58	19.0	67.2	13.8	0
1976	40	32.5	57.5	10.0	0
1977	51	31.3	49.1	19.6	0
1978	22	31.8	59.2	4.5	4.5
1979	33	3.0	84.9	12.1	0
Total and Averages	505	22.6	63.4	11.4	2.6

Table 2

COURTS OF APPEALS BY CIRCUIT
Compiled From Cases Reported In
United States Patent Quarterly Jan. 1969 to Aug. 1979

Circuit No.	Total No. of Patents Adjudicated	Valid and Infringed %	Invalid %	Valid but not Infringed %	Valid, but Infringement issue not reached %
1	25	20.0	72.0	8.0	0
2	49	18.4	69.4	12.2	0
3	35	31.4	65.7	2.9	0
4	40	15.0	60.0	25.0	0
5	70	34.3	41.4	20.0	4.3
6	59	23.8	52.5	20.3	3.4
7	101	22.8	65.3	6.1	5.0
8	15	20.0	73.3	0	6.7
9	75	16.0	76.0	5.3	2.7
10	24	12.5	70.8	5.2	12.5
D.C.	9	33.3	44.4	33.3	0
Total and Averages	505	22.6	63.4	11.4	2.6

IN THE UNITED STATES DISTRICT COURT

FOR THE SOUTHERN DISTRICT OF TEXAS

HOUSTON DIVISION

CLERK, U.S. DISTRICT COURT
SOUTHERN DISTRICT OF TEXAS
FILED
OCT 8 1976
BAILEY THOMAS, CLERK
BY DEPUTY

CATHODIC PROTECTION SERVICE,

Plaintiff,

V.

ASARCO INCORPORATED, ET AL,

Defendants.

CIVIL ACTION

NO. 72-H-1002

REVISED JUDGMENT

This cause came on to be tried before the Court sitting without a jury, the Court having considered the evidence introduced by the parties and the trial briefs and arguments presents on their behalf, and having heretofore made and filed its Revised Findings of Fact and Conclusions of Law, it is hereby

ORDERED, ADJUDGED, AND DECREED AS FOLLOWS:

1. United States Letters Patent No. Re: 27,529 and each and every claim thereof is good and valid in law.

2. Plaintiff, Cathodic Protection Service (CPS), is possessed of the entire right, title and interest in and to said Letters Patent No. Re: 27,529, which is a reissue of original United States Letters Patent No. 3,616,422, together with the right to sue for and collect for damages for past infringement thereof and has been possessed thereof continuously since the issuance of said original and reissue Letters Patents.

3. Defendants ASARCO Incorporated and Federated Metals Corporation, the former American Smelting and Refining Company and its Federated Metals Division, (ASARCO) and Wayne Broyles Engineering Company (BROYLES) have made and sold three types of bracelet anodes to wit: Type A was first sold after the issue of the original patent in 1971 and before the application for reissue was filed. Types B and C were made an

sold after December 12, 1972, the issue date of the reissue patent. The bracelet anodes have the following features: four (or eight in the case of Type B) arcuate segment anodes adapted to embrace a pipeline, with each segment having a continuous, arcuate body of galvanic anode metal, a cathodic metal core concentrically and entirely embedded within the anode metal adjacent to its inner periphery and comprised of either one single bar (Types B and C) or two axially-spaced apart metal bars (Type A). Types A, B and C have the end portions of the bars projecting from opposed longitudinal edges of the segments to form joint elements for connecting the segments in pipe-encircling relation.

4. ASARCO has infringed Claims 1-7 and 9-13 of the reissue patent by manufacturing and selling the Types A, B and C anodes (hereinafter called "the infringing anodes"). ASARCO has infringed Claims 1-7 and 9-13 of the reissue patent by actively encouraging and inducing BROYLES to infringe. ASARCO has contributorially infringed Claims 1-7 and 9-13 of the reissue patent by offering to BROYLES two or more pairs of segment anodes for assembly into one pair of semicylindrical segment anodes adpated to embrace a pipeline. The arcuate segment anodes, as manufactured by ASARCO with the concentric cores as specified in the claims of the reissue patent, are not staple articles or commerce suitable for non-infringing use.

5. BROYLES has infringed Claims 1-7 and 9-13 by acting alone and in concert with ASARCO to assemble and sell the infringing anodes.

6. The conduct of ASARCO and BROYLES evidences a program to eliminate CPS as a potential competitor by: (1) ASARCO's offering "advantageous" prices for the old ASARCO Bulletin 191 bracelet anodes to BROYLES and to other competitors of CPS; (2) ASARCO's refusing to sell zinc to CPS for the making of its patented anodes; and (3) ASARCO's offering to BROYLES a blanket "hold harmless" indemnity against liabilities arising out of Broyles' infringement.

7. Gordon L. Doremus and Jack C. Davis are co-inventors of both the original and reissue patents.

8. The original and reissue patents of CPS were duly and regularly issued in accordance with law.

9. CPS engaged in no inequitable conduct and practiced no fraud on the Patent Office.

10. The patent in suit is a pioneer patent which marks a distinct step in the progress of the anode bracelet art and offers for the first time since 1958 a viable alternative to the old ASARCO's Bulletin 191 anode.

11. Defendants, ASARCO Incorporated, Federated Metals Corporation, and Wayne Broyles Engineering Company, their officers, agents, servants, and employees, and those persons in active concert or participation with them who receive notice hereof, are hereby restrained and enjoined from and after the date hereof and until October 26, 1988 from directly or indirectly infringing said Letters Patent No. Re 27,529, and from making, using, or selling or causing to be made, used, or sold infringing bracelet anodes of the Types A, B or C and any infringing equivalent thereof.

12. Plaintiff is not entitled to recover from Defendants attorney's fees.

13. All relief sought by the counterclaim, as amended, of Defendants is denied and the counterclaim, as amended, is dismissed in its entirety.

14. Judgment is hereby entered against defendants for costs.

15. All other matters, including the determination of the actual amounts to be awarded as damages, are reserved for later disposition by this Court.

This judgment is final except for the finding of actual damages sustained by Plaintiff.

DONE AT HOUSTON, TEXAS this 8th day of October, 1976.

Carl O. Bue, Jr.
United States District Judge

APPROVED AS TO FORM:

Michael L. Brewster
Attorney for Plaintiff

Neil L. Conley
Attorney for Defendants

In the

United States Court of Appeals

For the Seventh Circuit

No. 79-1038

LEE BLACKSMITH, INC., an Illinois corporation,
Plaintiff-Appellee,

v.

LINDSAY BROTHERS, INC., a Wisconsin corporation,
Defendant-Appellant.

Appeal from the United States District Court for the Southern District of Illinois, Northern Division.
No. 77-C-1055—Robert D. Morgan, *Judge.*

ARGUED JUNE 15, 1979—DECIDED AUGUST 21, 1979

Before FAIRCHILD, *Chief Judge,* SWYGERT and PELL, *Circuit Judges.*

SWYGERT, *Circuit Judge.* This case concerns the validity of U.S. Patent No. 3,991,831 (Foster) covering the invention of a harrow used in cultivating ground for agriculture purposes. Lee Blacksmith, Inc. ("Blacksmith"), the owner of the patent brought this action against Lindsay Brothers, Inc. ("Lindsay") for inducing infringement. Lindsay counterclaimed alleging invalidity of the patent under 35 U.S.C. § 102(b) ("on sale" bar) and 35 U.S.C. § 103 (obviousness). The district court held the Foster patent valid and found Lindsay liable for infringement. We reverse. Without reaching the section 102(b) issue, we hold the Foster patent invalid for obviousness under section 103.

I

The Foster patent has one claim. The invention described in this claim is the combination of a harrow and a post-plowing cultivating implement, such as a disc harrow (parent implement). The harrow is attached rigidly to the frame of the parent implement by one or more support beams. As illustrated by Diagrams 1 and 2 below, an arm is pivotally connected to and depends on each beam for movement toward and away from the parent implement. An elongated rail is attached to the lower end of the arms and extends laterally therefrom so that it is parallel to the rearmost row of the soil-working parts of the parent implement. A series of spaced, parallel metal rods (teeth), attached to the rail, slant downwardly and toward one end of the rail and form an acute angle with the rail. The teeth are spaced six inches apart and the length of the teeth is such that the lower end of each tooth projects under the upper end of an adjacent tooth. An adjustable spring connected between the frame of the parent implement and the pivotal arms of the harrow urges the teeth into the ground, with the teeth usually being tilted back at an angle of about forty-five degrees.

The alleged unique feature of the Foster patent is the acute angle of the tooth to the rail and the spacing of the teeth so that the lower end of each tooth projects under the upper end of an adjacent tooth. In its findings of fact the district court stated that this construction of a harrow produces a synergistic effect in that "all, or effectively all of the earth traversed by the harrow . . . is engaged by a tooth . . . ."

II

When a patent's validity is challenged, the patent is presumed to be valid and the burden of establishing invalidity rests on the party asserting it. 35 U.S.C. § 282. The presumption of validity, however, does not exist against prior art which was not considered by the Patent Office when the patent was issued. *Allen Group v. NuStar, Inc.*, 575 F.2d 146 (7th Cir. 1974) (*per curiam*).

Lindsay produced before the district court two patents not cited: Sigmund U.S. Patent No. 3,574,320 and Hotchkiss Patent No. 3,090,448, and, relying on *Allen Group, supra*, contended that the presumption of validity should not apply to the patent in suit. But the district court found that the prior art relied upon by Lindsay was the same or no better than that considered by the patent examiner in issuing the patent.[1]

The district court's findings will not be set aside unless clearly erroneous.[2] The presumption of validity continues when the patent examiner has considered "equivalent references" to the prior art relied upon by the party claiming invalidity. *Laser Alignment, Inc. v. Woodruff & Sons, Inc.*, 491 F.2d 866, 871 (7th Cir. 1974). Thus for the purposes of determining obviousness on this appeal, the Foster patent will be presumed valid.

---

[1] Decision and Orders, Findings of Fact, p. 5, reads:

> 17. The harrow disclosed by Sigmund is one and the same "clodbuster" harrow shown in the Noble brochure which was before the Examiner.
>
> 18. The harrow of Hotchkiss is a drag in that it engages the earth only by virtue of its own weight, and in that respect it is no different from the harrow shown in Adix 839,800. Hotchkiss does make provision of a harrow in combination with a post-plowing cultivating implement and does make provision for lifting the harrow to a transport position, but Vigen 3,500,936 makes the same provision. Both Adix and Vigen were considered by the Examiner.
>
> * * *
>
> 20. The prior art presented to the court at trial is no better in function, or more material or relevant to the invention claimed by the Foster patent in suit, than the prior art considered by the Patent Office.

[2] There is some doubt as to whether the district court finding of fact ¶20 is correct. The court determined that the Noble brochure which was before the patent examiner was equivalent to the Sigmund patent. The brochure did not specify the length or the spacing of the teeth on the rail. Because we believe that the obviousness issue controls whether the patent is presumed valid, we find it unnecessary to consider this problem in detail.

35 U.S.C. § 103 provides:

> A patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

In *Graham v. John Deere Co.*, 383 U.S. 1 (1966), the Supreme Court outlined the proper analysis to be followed when obviousness is at issue.

> While the ultimate question of patent validity is one of law [citation omitted], the § 103 condition, which is but one of three conditions, each of which must be satisfied, lends itself to several basic factual inquiries. Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved.

Id. at 17. "[T]he *Graham* analysis [is] the exclusive means by which to measure nonobviousness under section 103." *Republic Industries, Inc. v. Schlage Lock Co.*, No. 77-1872 (7th Cir., Feb. 1, 1979).[3]

In its findings the district court stated that Lindsay did not offer "evidence of any kind on the level of ordinary skill at any time in any art of farm earthworking equipment." The district court then concluded that because Lindsay had failed to establish evidence on one of the factual inquiries as required by *Graham*, the defendant had not overcome the presumption of validity. The district court's conclusion would be correct if *Graham* required that in every case the level of skill in the pertinent art must be resolved. This reading of *Graham* is overbroad.

[3] The district court's conclusion that the Foster patent produces a synergistic effect is irrelevant when making a determination of obviousness. *See Republic Industries, supra.*

The district court incorrectly relied on *Universal Athletic Sales Co. v. American Gym*, 546 F.2d 530 (3d Cir. 1976), in reaching its conclusion. In *Universal* the Third Circuit held that a district court could not invalidate a patent when the record was deficient with respect to evidence on the level of skill. But this rule is not without exception.

The correct rule was formulated by this court in *Research Corp. v. Nasco Industries, Inc.*, 501 F.2d 358 (7th Cir.), *cert. denied*, 419 U.S. 1096 (1974). In *Research Corp.* a patent was held obvious on a motion for summary judgment. No evidence had been heard on the level of skill in the pertinent art. The court stated:

> Here there was no factual dispute concerning the state of the prior art, as recorded in the Taylor article. The differences between the method there disclosed and the claimed invention are plainly discernible from the documents, . . . A full trial, for the sole purpose of hearing expert testimony on the level of ordinary skill in the art, could not have aided the court in resolving the legal question of obviousness, and the court could properly rule on that issue "without the taking of testimony from experts in the pertinent area of knowledge." (citation omitted) *Id.* at 361.

The court further held that this method of determining obviousness was appropriate

> . . . where the structure and mode of operation of the accused device may be readily comprehended by the court and compared with the invention described and claimed in the patent without need of technical explanation by expert witnesses. (citation omitted) *Id.* at 362.

The gist of our holding in that case is that if the differences between the patent in suit and the prior art are such that the subject matter as a whole is obvious to a layman, a determination of the level of skill on the basis of expert testimony in the pertinent art would be useless. What is obvious to a layman would certainly be obvious to one skilled in the art to which the subject matter pertains.

III

Having delineated the proper standard for evaluating obviousness, we turn to the question of the instant patent's validity.

The Sigmund patent, U.S. Patent No. 3,574,320, is pertinent prior art relating to the Foster patent. The district court said as much when it found that the Sigmund patent was the "one and the same" harrow contained in a brochure which was before the patent examiner. On the Sigmund harrow, the teeth are attached to the rail at a ninety degree angle and are spring-urged toward the ground, much like the Foster harrow. The specifications of the Sigmund patent provide that the rail to which the teeth are attached "is disposed at a 45 degree angle with respect to the direction of travel. . . . [This] insures that the teeth will slice through the plow furrows at a 45 degree angle instead of paralleling a continuous unbroken furrow [resulting] in a more efficient and effective mulching of the soil." Plaintiff's Exhibit 7. The Foster harrow which Blacksmith manufactures is constructed with the teeth at a forty-five degree angle to the rail. As can be seen from Diagram 3 the teeth plow through the ground at a forty-five degree angle with respect to the direction of travel in both the Sigmund and Foster harrows. Although it cannot be seen from the diagram, the teeth on both harrows are also tilted up from the ground at approximately a forty-five degree angle (*see* Diagram 2). Thus the teeth in Sigmund and Foster are in the ground in precisely the same attitude.

Further, the Foster patent provides that the teeth be spaced six inches apart and that the lower end of each tooth is beneath the upper end of an adjacent tooth. When the teeth are pulled through the soil at a forty-five degree angle, each tooth disturbs a swath of ground wider than the tooth itself. Overlapping the teeth, *i.e.*, placing the bottom of one tooth below the top of another, ensures that all of the ground between any two teeth is thoroughly mulched. This characteristic is merely a function of the length and spacing of the teeth. It is substantially met by the Sigmund patent where it is stated:

> It is also preferred that the teeth be spaced apart on 5-1/2 inch centers. . . . It is also preferred that the teeth extend approximately 12 inches below the lower flange of the [rail]. Plaintiff's Exhibit 7.

These specifications in conjunction with the fact that the rail is carried at a forty-five degree angle to the direction of travel ensures that all of the ground is disturbed by a harrow constructed in accordance with the Sigmund design as it is by the Foster harrow. With respect to the direction of travel (*see* Diagram 3), the bottom of each Sigmund tooth is "below" the upper end of an adjacent tooth.

Thus the Foster patent was designed in a way which achieves the identical results of the Sigmund patent. The teeth of the harrow are the only working parts which affect the soil. In Sigmund and Foster the rails are in different positions with respect to the direction of travel, but the teeth are always in the same position relative to the ground. Attaching the teeth to the rail at a forty-five degree angle and then adjusting the position of the rail are differences from the Sigmund structure that can only be characterized as obvious. No expert testimony from one skilled in the art of harrowing and mulching tillable ground was needed in the trial to prove this fact.

The argument does not end here. It is Blacksmith's position that when the Foster harrow is turned twenty degrees from the direction of travel, it can be used behind a disc harrow, as well as a field cultivator. Blacksmith argues that the Foster harrow still disturbs all or effectively all of the soil when turned twenty degrees whereas the Sigmund harrow cannot be used effectively at this angle. Although this feature may be true, it cannot be found in the Foster patent. "[T]he claims of a patent limit the invention" and ". . . claims are to be construed in light of the specifications." *United States v. Adams*, 383 U.S. 39, 48-49 (1966). *See also Laser Alignment, Inc. v. Woodruff & Sons, Inc.*, 491 F.2d 866, 872 (7th Cir. 1974) (claims of a patent are the measure of its grant). The patentability of the Foster invention cannot be based on a feature which is not articulated in the patent's claim.

Finally, Blacksmith argues that we should weigh secondary considerations such as commercial success, unexpected and beneficial results, and imitations. *See Graham, supra*, 383 U.S. at 17-18. Although these considerations may be "indicia of obviousness or nonobviousness," *id.* at 18, they may be weighed "[o]nly in a close case, in which application of the primary criteria of nonobviousness under section 103 does not produce a firm conclusion. . . ." *Republic Industries, supra.* Here the application of section 103's criteria creates no doubt about a determination that the Foster patent is invalid for obviousness.

The judgment of the district court is reversed.

Diagram 1

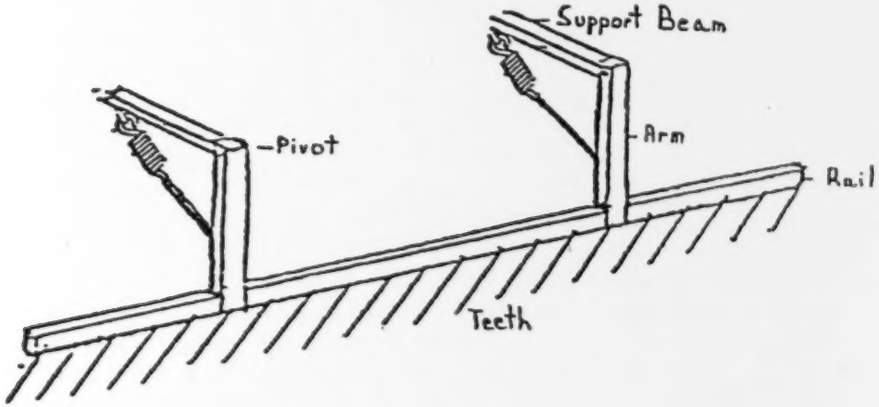
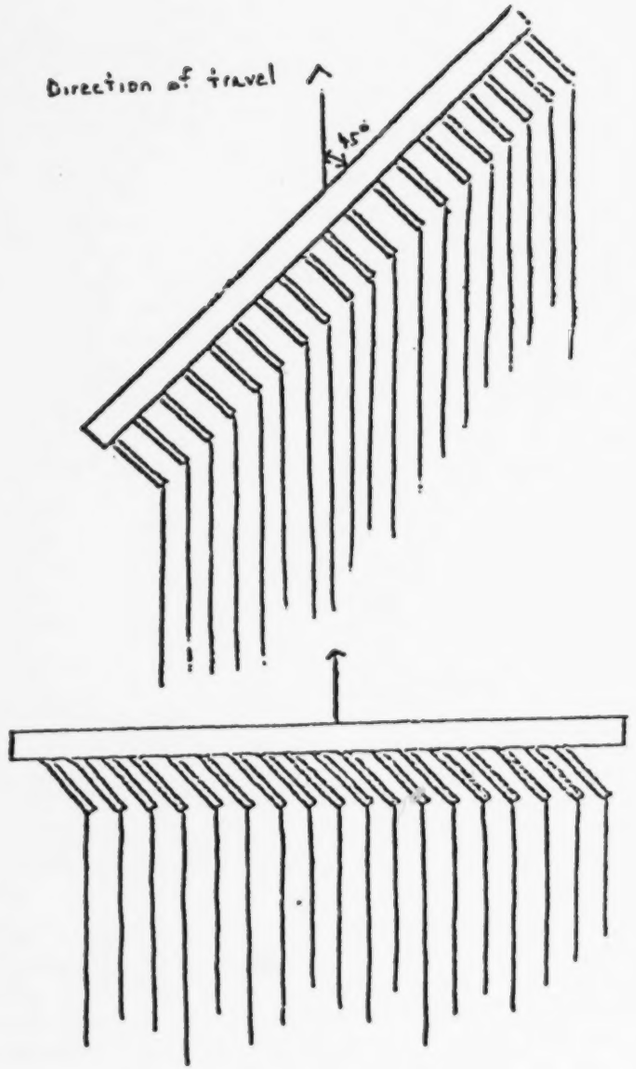


Diagram 2



Diagram 3



PELL, *Circuit Judge*, dissenting.

The majority opinion demonstrates that a federal judge with long experience in the patent law field had no particular difficulty in finding that the Foster patented invention was obvious in view of prior art. The record here, on the other hand, demonstrates that that ease of perception was not shared by some ten of the plaintiff's competitors who imitated and were inspired by the plaintiff's patented harrow. I fail to see why these competitors who were in the same business could not be characterized as being persons of ordinary skill in the relevant art. I regard the fact of imitation as developed in this case as being a strong indicia of nonobviousness sufficient, and when coupled with the presumption of validity, sufficient to require affirmance of the judgment of the district court. Accordingly, I respectfully dissent.

In the majority opinion the matter of imitations is swept under the rug along with commercial success and unexpected and beneficial results. Aspects such as these are characterized in numerous judicial opinions as "secondary considerations." The majority opinion is breaking no new ground in adopting this characterization. It does appear to me that in relegating some of these aspects, which perhaps are secondary in time at least, the courts have minimized their probative value reflecting upon whether there is obviousness. I must concede that some of the trappings which have been judicially developed on the "secondary considerations" syndrome are probably so firmly entrenched that a realistic reevaluation can now only be forthcoming from the Supreme Court.

While I regard the matter of imitating a patented article by numerous competitors as being direct and positive evidence of nonobviousness, not to be relegated to a secondary consideration which only comes into play in close cases, I also recognize the breadth of language in the cases dealing with these so-called secondary considerations, including cases in this court in which I have either been the author of the opinion or a member of the panel which handed down the opinion. *Panduit*

Corp. v. Burndy Corp., 517 F.2d 535, 541 (7th Cir. 1975), *cert. denied*, 423 U.S. 987; *Republic Industries, Inc. v. Schlage Lock Co.*, 592 F.2d 963 (7th Cir. 1979).

The landmark case on the evaluation of obviousness under section 103 is, of course, *Graham v. John Deere Co.*, 383 U.S. 1 (1966). After referring to the three conditions which must be satisfied, which standards are adverted to in the majority opinion, the Court states:

> Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy.

383 U.S. at 17-18. I do not read *Graham* as stating that all secondary circumstances only have relevancy when the case is close as to obviousness. Further, the only reason that I can conceive that an inquiry might have relevancy for the purpose of throwing light on the circumstances surrounding the origin of the subject matter sought to be patented would be the reflective one of whether as a matter of law there was obviousness. If there was not this reflective aspect there should appear to be no relevancy. I must confess also to having difficulty in determining the precise meaning of "indicia." I can only assume that this must refer to some probative evidentiary value even though, dependent upon its nature, it may be given little weight, particularly if the nexus of the so-called "secondary consideration" to the invention is weak. I would not construe *Graham*, however, as mandating a disregard of any pertinent probative evidence on the question of obviousness.

Other cases, indeed earlier cases, without referring to the aspects under consideration as secondary have dealt with the present issue. Thus in *Jungersen v. Ostby & Barton Co.*, 335 U.S. 560, 567 (1949), the Court held that the fact that the patented process had enjoyed considerable commerical success did not render it valid. The

Court then stated that it is true that in cases where the question of patentable invention is a close one, such success has weight in tipping the scales of judgment toward patentability. In the case before the Court, however, invention was plainly lacking and commercial success could not fill the void. In the case before this court I cannot agree with the majority opinion that invention is plainly lacking. Also I do not concede that all of the so-called secondary considerations are of equal stature as to probative value. Commercial success, of course, may be achieved by diligent huckstering and in that event would have no bearing whatsoever on the question of obviousness.

In a case a year later, *Great Atlantic & Pacific Tea Co. v. Supermarket Equipment Corp.*, 340 U.S. 147, 153 (1950), the lower courts had both leaned heavily on evidence that the device filled a long-felt want and had enjoyed commercial success. The Court then opined that commercial success without invention would not make patentability. The Court did not expressly deal with "long-felt want" but I think a proper reading of the opinion would indicate that where there was nothing, as was true in that case, except combining well known elements in the prior art obviousness must be found to exist even though there was long-felt want. Unfortunately, the Court ignored the fact that patentable inventions have been properly upheld which combined old elements in the prior art where the combining would not have been obvious to those skilled in the art.

Again, in *Anderson's-Black Rock v. Pavement Salvage Co. Inc.*, 396 U.S. 57, 61 (1969), the Court reiterated that matters such as long-felt want and commercial success will not make patentability "without invention," citing *Great Atlantic & Pacific Tea Co, supra.*

In this dissent I will leave aside any reliance on commercial success, although that was ample in the present case, and long-felt need, even though with regard to this latter aspect I confess difficulty in not giving more significance than recent cases in this court and other courts have to the evidence of long-felt and unsolved want throughout an industry having skill in

the art which for long times has been unable to solve a problem. I have the difficulty of discerning how something could be obvious to those of ordinary skill in the art if in the industry where those people labor the want was felt and those people could not solve it. In any event my reliance here is on the matter of imitation as to which I cannot find that the Supreme Court has dealt expressly, although in the much earlier case of *Diamond Rubber Co. v. Consolidated Rubber Tire Co.*, 220 U.S. 428, 441 (1911), the Court did remark on the fact that prior art was crowded with numerous prototypes and predecessors but yet while giving the tribute of praise to the prior art, the competitor gave the patented tire, "the tribute of its imitation as others have done."

In two cases at least in this court the importance of imitation by competitors has been found to be significant. In *Ekstrom-Carlson & Co. v. Onsrud Machine Works*, 298 F.2d 765, 770 (7th Cir. 1962), *cert. denied*, 369 U.S. 886, this court, after referring to the well established rule of law that when a novel combination of elements whether all new, or all old, or partly new and partly old, so cooperate as to produce a new and useful result or a substantial increase in efficiency such combination is patentable, stated:

> When we add to the foregoing rule on combinations the fact that the disclosures of the patent in suit first solved the long existing problem facing the aircraft industry, the acceptance of the patented device by the industry and *defendant's imitation of plaintiff's machine*, the defense of obviousness must fall. (Emphasis added).

Also, in *Welsh Co. v. Chernivsky*, 342 F.2d 586, 591 (7th Cir. 1965), *cert. denied*, 382 U.S. 842, this court agreed with the district court's conclusion that the commerical success achieved by the patented object with only modest promotion and the fact that still another competitor had copied it in virtually every detail, while not sufficient of itself to establish the validity of the patent, did support the inference that the device was unobvious and filled a need.

The principal error, as I regard it in the majority opinion in the present case, is that the court declines to give any weight whatsoever to the aspect of imitation. The district court in its findings of fact expressly found the fact that Chromalloy and another competitor imitated and were inspired by plaintiff's patented harrow and the fact that other competitors followed in those same footsteps manifests that the claimed invention would not have been obvious to a person of ordinary skill in the art to which the subject matter of the patent pertains. The fact before we reach the legal question of obviousness that there was imitation not only by Chromalloy but by numerous other competitors is not challenged as being erroneous. Looking particularly at the Chromalloy situation, that company heard about the plaintiff's harrow from some of its salesmen in the field, and then conducted an extensive poll of its salesmen. From the poll and volunteered remarks of its salesmen Chromalloy heard opinions that plaintiff's harrow "was the machine of the future" and that Chromalloy should "either procure one or build one." Shortly after the poll Chromalloy personnel visited plaintiff, took photographs of plaintiff's harrow, sketched it, measured its components and recorded the measurements on the sketch. The photographs and sketches were in the possession of Chromalloy's engineering department when the drawings for the Chromalloy harrow were made, and the district court found that that harrow incorporated the invention of the Foster patent.

In the few cases dealing with the matter of imitation as bearing on obviousness there apparently was one or two at the most who had copied the patented invention. Here at least nine other competitors followed in the plaintiff's footsteps.

In sum, I fail to see how we can determine that a case is not a close one or that an invention is clearly obvious without considering what I regard as the most relevant evidence in the case. I think it is time that the courts re-

look at the question of relegating perhaps the most direct and positive evidence of nonobviousness to second class status.[1]

A true Copy:

Teste:

Clerk of the United States Court of Appeals for the Seventh Circuit

[1] With regard to the issue raised by the counterclaim of invalidity under 35 U.S.C. § 102(b) ("on sale" bar) I agree with the district court's finding that there was no public use.

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OCT 24 1979

IN THE

Supreme Court of the United States

OCTOBER TERM, 1979

No. 79-506

CATHODIC PROTECTION SERVICE, A PARTNERSHIP,

Petitioner,

v.

AMERICAN SMELTING AND REFINING COMPANY (ASARCO)
AND
WAYNE BROYLES ENGINEERING COMPANY (BROYLES),

Respondents.

ON PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

RESPONDENTS' OPPOSITION TO WRIT

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October 24, 1979

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APPENDIX A-1

IN THE

Supreme Court of the United States

OCTOBER TERM, 1979

No. .....

CATHODIC PROTECTION SERVICE, A PARTNERSHIP,
Petitioner,

v.

AMERICAN SMELTING AND REFINING COMPANY (ASARCO)

AND

WAYNE BROYLES ENGINEERING COMPANY (BROYLES),
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ON PETITION FOR WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FIFTH CIRCUIT

RESPONDENTS' OPPOSITION TO WRIT

STATEMENT OF THE CASE

To supplement Petitioner's statement of the case we invite the Court's attention to the fact summary in the opinion of the Court of Appeals, and we include in the

Appendix a copy of the patent in suit, some of the most pertinent prior art relied upon by Respondents, which was omitted from Petitioner's Appendix D, and a more clear drawing of the Bulletin 191 Anode. We note further that the article, Appendix D13 to the Petition, which Petitioner alleges was presented to the Patent Office as prior art (Petition footnote 5, pg. 30) was not prior art, being dated October 1969, six months after the patent application was filed, and was not identified to the Patent Examiner as prior art (Plaintiff's Exhibit 44, A.975).

Petitioner failed to mention that the District Court's decision was reversed because the Court of Appeals found that its fact findings on scope and content of the prior art and level of ordinary skill in the art were clearly erroneous (Petition B-18). The error was principally due to the fact that the trial court had held certain prior art to be irrelevant, despite the fact that this prior art was from the same field of galvanic anodes and also disclosed the same functional or mechanical features as claimed in the patent, and despite the fact that such art was considered relevant by the inventor, his original patent attorney, an attorney who made a prior art search, and the Patent Office Examiner (Petition B-20). The Court of Appeals also noted that this prior art had not been disclosed to the Patent Examiner, even though much of it had been called to Petitioner's attention for this specific purpose (Petition B-9).

Defendants in the case below are Asarco Incorporated, Federated Metals Corporation and Wayne Broyles Engineering Company. All of these wish to respond to the Petition.

REASONS FOR DENYING THE WRIT

Summary

The writ of certiorari should be denied because Petitioner has made none of the showings suggested by Rule 19 of this Court. There is no showing of any conflict between the decision of the Court of Appeals in this case and that of another Court of Appeals on the Question Presented. Petitioner admits that there is no conflict between the decision in this case and the most recent applicable decisions of this Court. The alleged important question of federal law has, as is apparent from Petitioner's own argument, already been settled by this Court. Petitioner is merely saying that it does not agree with what the Court of Appeals did. There is no special and important reason given why this Court should review *this* case.

The Court of Appeals in this case specifically addressed the underlying factual inquiries required by *Graham* v. *Deere,* 383 U.S. 1 (1966), and concluded that the invention was obvious in view of prior art which the trial court had considered irrelevant. Petitioner has neither urged nor demonstrated any error in the Court of Appeals' findings on these factual inquiries.

Thus the Question Presented is devoid of any conflict, and presents no important question of federal law for this Court.

Argument

Petitioner's primary argument is that this court has, in such decisions as *Anderson's-Black Rock, Inc.* v. *Pavement Salvage Co., Inc.,* 396 U.S. 57 (1969); *Sakraida* v. *Ag Pro, Inc.,* 425 U.S. 273 (1976); and *Dann* v. *Johnston,* 425 U.S. 219 (1976), when viewed in the light of *Graham, supra,* created confusion and needless uncertainty as to how the

Patent and Trademark Office or a lower court is to approach and analyze the issue of obviousness, particularly in connection with how to deal with "secondary considerations". To support its argument Petitioner has created two allegedly distinct "methods" of deciding questions of obviousness, the "visceral reaction method" and the "Learned Hand/CCPA approach". We submit that there are not different methods, but only different fact situations, and that the various Supreme Court pronouncements on the issue of obviousness are neither confusing nor inconsistent, but in fact are remarkably consistent, considering the wide variety of fact situations that have been presented.

Petitioner's argument ignores the fact that this Court, in the *Graham* Trilogy, concluded that the enactment of 35 U.S.C. § 103 was not a change in the law but a codification of judicial precedents:

> "We believe that this legislative history, as well as other sources, shows that the revision was not intended by Congress to change the general level of patentable invention. We conclude that the section was intended merely as a codification of judicial precedents embracing the Hotchkiss condition, with congressional directions that inquiries into the obviousness of the subject matter sought to be patented are a prerequisite to patentability." (383 U.S. at 17).

The Court had already noted, at 383 U.S. 12, that *Hotchkiss* v. *Greenwood,* 11 How. 248, 13 L.Ed. 683 (1851), had required a comparison between the subject matter of the patent and the background skill of the calling, and that patentability was in each case determined from that comparison. This was directly related to the requirements of Section 103, by noting that under this section "the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are

to be ascertained; and the level of ordinary skill in the pertinent art resolved" (383 U.S. 17-18).

The Court then went further and noted that such secondary considerations as commercial success, etc. "may have relevancy". In the light of the Court's previous determination that Congress had not intended to change the general level of patentable invention, but had merely intended to codify judicial precedents, it is apparent that one may look to earlier decisions of the Court to determine the circumstances under which these "secondary considerations" are relevant.

In one such case, *Jungersen* v. *Ostvy and Barton Co.,* 335 U.S. 560 (1948), the Court stated:

> "It is true that in cases where the question of patentable invention is a close one, such success has weight in tipping the scales of judgment toward patentability .... where, as here, however, invention is plainly lacking, commercial success cannot fill the void." (355 U.S. at 567).

In a much earlier case, *Smith* v. *Goodyear,* 93 U.S. 486 (1877), the Court spoke in a similar vein:

> "We do not say, the single fact that a device has gone into general use and has displaced other devices which had previously been employed for analogous uses, establishes in all cases that the later device involves a patentable invention. It may, however, always be considered; and, when the other facts in the case leave the question in doubt, it is sufficient to turn the scale." (93 U.S. at 495-496).

These are only two of the many cases decided before the enactment of Section 103 and the decision in the *Graham*

Trilogy in which this principle was reaffirmed.* There is no question that the law prior to Graham was that if "invention" is plainly present or plainly lacking, the presence or absence of "secondary" factors did not tip the scales in the other direction.

The *Graham* Trilogy itself contains, in its analysis of the Cook Chemical patent, an excellent example of application of the rule concerning secondary considerations (383 U.S. 35-37). Here the Court noted the evidence of failure of others, long felt need, and commercial success, and observed that such sub-tests are "more susceptible of judicial treatment than are the highly technical facts often present in patent legislation", that such inquiries may lend a helping hand, and "guard against slipping into hindsight". Nevertheless, the Court, noting the exceedingly small differences from the prior art, held that those factors do not, in the circumstances of the case before the Court, tip the scales of patentability.

The Supreme Court cases following *Graham* which have dealt with the law on obviousness have been consistent with *Graham* and the cases preceding *Graham*.

In *Black Rock* the Court, in response to argument that the patented combination filled a long felt want and enjoyed commercial success, stated that those matters "without invention will not make patentability" (396 U.S. at 61, citing *Great A & P Co.* v. *Supermarket*, 340 U.S. 147 (1950).

In *Dann*, although there was no contention that secondary considerations supported respondent's claim of non-obvi-

*Note, for example, *Topliff* v. *Topliff*, 145 U.S. 156, 163 (1892); *Potts* v. *Creager*, 155 U.S. 597, 609 (1894); *Textile Machine Works* v. *Louis Hirsch Textile Machines*, 302 U.S. 490, 498-499 (1934); *Dow Chemical Co.* v. *Halliburton Oil Well Cementing Co.*, 324 U.S. 320, 330 (1945); and *Toledo Pressed Steel Co.* v. *Standards Parts, Inc.*, 307 U.S. 350, 356-357 (1939).

ousness, the Court noted that "commercial success without invention will not make patentability", citing *A & P*, and that such considerations may be relevant in a determination of obviousness, citing *Graham* (425 U.S. 230, fn. 4).

In *Sakraida, A & P* was cited once more in holding that desirable benefits, including commercial success, will not make patentability (425 U.S. 282-283).

Thus, as petitioner tacitly admits (Petition, p. 15), this Court's handling of the obviousness question in the cases after *Graham* is consistent with *Graham*. The law on the question is well-settled, and no reason appears for considering it further.

Contrary to Petitioner's argument, there is no confusion on the question among the courts of appeal.

Respondents have reviewed the circuit courts of appeal cases which Petitioner has selected as examples of the alleged "visceral reaction" and "Learned Hand/CCPA" approaches, and have found no instance in which a court of one circuit disagreed with a court of another circuit as to the law on obviousness, and no basis whatsoever for Petitioner's juxtaposition of the circuits. On the contrary, each of the cases cited *Graham*, and they all carefully followed the *Graham* tests in their determination of obviousness or non-obviousness. In each of the cases where the court found either obviousness or non-obviousness to be clear cut, it found it unnecessary to consider secondary factors. Where the court found a close question, secondary factors were discussed and applied. In some cases a court, having reached a conclusion of obviousness or non-obviousness, also discussed secondary factors as bolstering the conclusion which had already been reached.

Considering the divergence of fact situations which were presented in the various cases, they are remarkably con-

sistent in their application of what is admittedly a difficult legal concept.

Even Petitioner's reliance on the Court of Customs and Patent Appeals is misplaced. Although the court has on occasion relied on the secondary considerations in its determinations of non-obviousness, it has also, on occasion, found them non-persuasive. See, e.g., *In re Palmer,* 451 F.2d 1100 (CCPA 1971), cited by Petitioner. Furthermore, the CCPA does not consider its position to be inconsistent with *Black Rock* or *Graham.* In *Application of Fielder,* 471 F.2d 640 (CCPA 1973), cited by Petitioner, the court concludes that *Black Rock* is a reaffirmation of, rather than a deviation from *Graham.* The Court noted that the *Black Rock* Court "was not persuaded of non-obviousness by the showing by that patentee on the facts of that case" (471 F.2d at 645). In *Fielder* the CCPA was also not persuaded.

In the present case, the Court of Appeals, noting that six Supreme Court opinions which have dealt with the subject of invention in the last three decades guided its determination (Petition B-16), quoted the *Graham* language on standard of invention, and carefully followed this standard in its analysis of the facts of this case. After concluding from this analysis that the trial court's findings of the *Graham* facts were clearly erroneous, and that the claimed invention was clearly obvious, it noted Petitioner's urging of secondary considerations. The court observed that the trial court had used these considerations only to bolster its conclusion of non-obviousness and then, citing as authority this court's opinions in *Black Rock, A & P, Sakraida,* and *Goodyear,* held that because "the claims made here are clearly obvious, we need not examine the secondary considerations." (Petition B-33).

The court did not find it necessary to examine the foundation for the district court's findings on secondary considerations. If it had done so it would have found that the findings were clearly erroneous. Contrary to the finding of the district court on commercial success, for example, the patented anodes made little impact in the industry. Petitioner itself continued to sell the prior art Bulletin 191 Anode (A.536). One of its competitors sold the Bulletin 191 Anode continuously, had been unable to sell the allegedly infringing design, and had lost only two orders to the Petitioner in five or six years (A.632). Respondent, ASARCO, sold only four orders of the allegedly infringing design, all other sales being of the Bulletin 191 design (A.640-641). Defendant Broyles never lost any customers to the patented design and did not detect any diminishing in sales of the Bulletin 191 design (A.701).

It is apparent, therefore, that any success that Petitioner's anode design had was based soley on Petitioner's efforts to market its patented design rather than the prior art design. Certainly, the patented design did not supplant or practically eliminate sales of the Bulletin 191 anode, as found by the district court.

The real issue in this case, as indicated by the Question Presented, is only whether the Court of Appeals was correct in holding, on the facts of this case, that the patent in suit is invalid. That issue is of no importance to anyone except the parties to this case, and should not be the basis for the grant of certiorari.

Conclusion

The law on obviousness under § 103 of the Patent Laws was thoroughly explored by this Court in *Graham.* Since then, opinions of this Court and of the Courts of Appeal

have followed the instructions in *Graham*. Different fact situations necessitated different results. In the present case the Court of Appeals followed the same instructions. The facts found compelled the conclusion of obviousness. The petition should therefore be denied.

Respectfully submitted,

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Dec. 12, 1972 G. L. DOREMUS ET AL Re. 27,529

GALVANIC ANODE

Original Filed April 21, 1969

FIG. 1

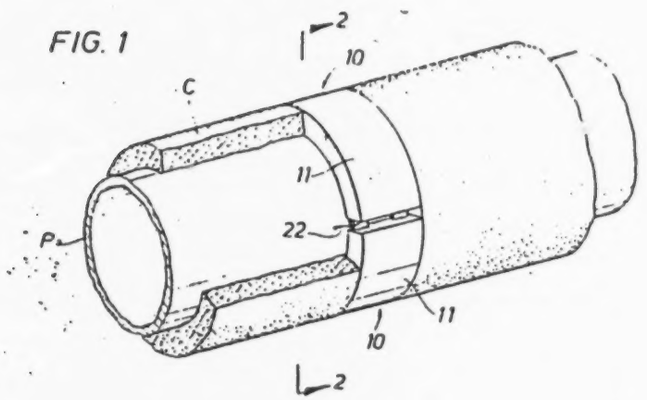
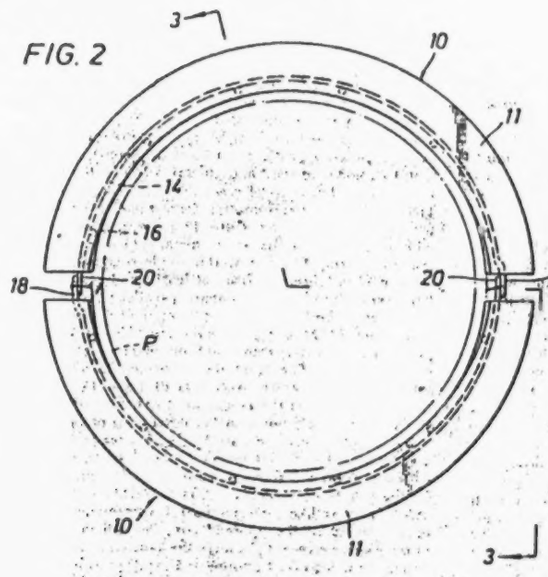


FIG. 2



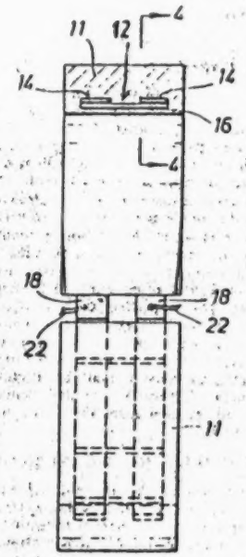


FIG. 3

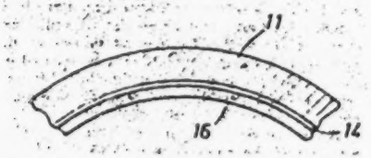


FIG. 4

Gordon L. Doremus &
Jack G. Davis
INVENTORS

BY

ATTORNEY

United States Patent Office

Re. 27,529
Reissued Dec. 12, 1972

1

27,529

GALVANIC ANODE

Gordon L. Doremus, 7555 Haywood Drive 77017, and Jack G. Davis, 3600 Montrose, Apt. 405 77006, both of Houston, Tex.

Original No. 3,616,422, dated Oct. 26, 1971, Ser. No. 817,916, Apr. 21, 1969. Application for reissue Aug. 7, 1972, Ser. No. 277,381

Int. Cl. C23f 13/00

U.S. Cl. 204—197 14 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A galvanic anode adapted particularly for the cathodic protection of relatively large diameter pipelines submerged in water bodies. The anode consists of *at least* a pair of [semicylindrical] *arcuate* segments constructed of a suitable galvanic metal and having completely embedded within the galvanic metal steel core or armature sections, adapted to be connected together to join the anode sections into a "bracelet" about the pipe.

BACKGROUND OF THE INVENTION

Cathodic protection of submerged pipe lines is currently accomplished by means of so-called bracelet anodes which conventionally consist of semicylindrical segments each fabricated from a plurality of arcuate anode segments, each of which has a longitudinal steel core protruding from the opposite ends thereof. The protruding ends of the cores are welded to semicircular steel bands external to the anode material. The construction of this type of anode is wasteful of labor in requiring multiple handling of the several pieces in forming each bracelet segment. Moreover, the resulting half-bracelets are mechanically weak and often badly deformed in shipping and handling. This is particularly true where anodes are required for relatively large diameter pipe lines, for example 24 inch and larger, for which a relatively large number of arcuate segments are required to make up each half bracelet. This conventional construction also results in a large area of exposed bare steel demanding protective current of its own from the anode material unless properly coated.

SUMMARY OF THE INVENTION

The deficiencies of the above-described conventional bracelet anodes are obviated by the *preferred* construction contemplated by the present invention wherein each half-bracelet is cast *preferably* as a continuous semicylindrical segment of anode metal in which is completely embedded, during casting of the anode, a concentric steel core or armature. The latter consists of a pair of spaced-apart, parallel straps made from mild sheet steel *preferably* cross-linked with small diameter steel rods. The ends of the cores protrude from the ends of the anode segments and are provided with offset portions of complementary shape adapted to form the joints by which the segments are connected together to complete the bracelet. Short bending tabs are provided for attachment to the armature joints for electrically connecting [the cores] *each strap* to the (cathodic) pipe metal to be protected.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates a [useful] *preferred* embodiment in accordance with this invention:

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, partly in section, showing the anode, in accordance with *the preferred embodiment of* this invention, mounted on a pipeline which is also encased in a protective and weighting coating of cement;

FIG. 2 is an end elevational view of the anode;

FIG. 3 is a side view partly in elevation and partly in section taken on line 3—3 of FIG. 2; and

FIG. 4 is a fragmentary cross-sectional view taken along line 4—4 of FIG. 3.

Referring to the drawing, the anode comprises *at least* a pair of identical *of arcuate but preferably* semicylindrical segments, designated generally by the numerals 10, and adapted when joined at their ends, to completely embrace a pipe P to be protected thereby. By reason of their identical construction, the description of one segment will be equally applicable to the other.

The segment 10 comprises a solid one-piece, semicylindrical body 11 of a suitable anode metal, such as zinc, aluminum, magnesium and alloys thereof, and is formed to an inner radius substantially equal to that of the outside of the pipe about which *it* is to be disposed so as to fit closely thereabout. The angular length of body 11 is made slightly less than 180° to provide a short open space between the opposed ends of the segments to accommodate the joints between the core sections by which the anode segments are connected together as will appear subsequently. The several end surfaces of body 11 are made substantially flat as illustrated.

Body 11 is provided with an armature or core, designated generally by the numeral 12, constructed of a metal cathodic to the anode metal. Preferably the metal is mild steel but may be any other metal sufficiently below steel in the electromotive force scale to be effective for cathodic protection. Core 12 is completely enclosed within the body of the anode metal which is cast about the core during forming of the anode segment.

Core 12 is fabricated from at least two bars 14—14 of flat steel disposed in spaced-apart, parallel relation. [and] *To enhance the mechanical and electrical integrity of the core, bars 14–14 are preferably* cross-linked by a plurality of angularly-spaced, small-diameter steel rods 16 to provide a latticelike structure is formed to a curvature substantially concentric with that of body 11 and on a radius intermediate the inner and outer radii of body 11, so as to lie closely adjacent the inner wall of body 11.

The length of *each of* bars 14 [are] *is* made sufficiently greater than the angular length of body 11 to project short distances from the opposite ends of the latter. One projecting end 18 of each bar is offset laterally outwardly to define a socketlike joint member for receiving the non-offset end 20 of the opposed core bar which forms the other joint member by which the cores of the opposed anode segments may be connected together as by welding, in order to complete the bracelet-type anode for the pipe about which it is mounted, as best seen in FIGS. 1 and 2.

Since these bracelet-type anodes are ordinarily installed over the conventional corrosion barrier coating on the pipe, short bonding cables 22 may be secured to the completed bracelets, preferably at the joints between the core segments, and suitably bonded to the pipe metal to complete the protective circuit.

When the described anodes have been placed about pipe P and the cores connected to the pipe, as seen in FIG. 1, the pipe, particularly if it is to be submerged in marine bodies, may be encased with cement C (FIG. 1) for weighting and additional protective purposes in accordance with conventional practices.

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From the foregoing, it will be evident that the bracelet anodes [constructed] *based on the preferred construction* in accordance with this invention, provide a simple, easily fabricated, solid structure, which may be installed with a minimum of labor cost to provide highly effective cathodic protection for a pipeline.

While the preferred embodiment of this invention desirably employs only a single pair of segments to minimize the amount of exposed steel external to the cores and to minimize the number of required welds, it will be apparent to those skilled in the art that a plurality of such segments could be employed without departing from the scope of this invention, since the steel bands within the segments would be entirely embedded and only their end portions projecting from the segments would be exposed.

What we claim and desire to secure by Letters Patent is:

1. A galvanic anode for cathodic protection of pipe lines, comprising:

(a) a pair of semicylindrical segments adapted to embrace a pipeline, each segment comprising:

(1) a continuous, semicylindrical body of a galvanic anode metal;

(2) A metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body;

(2) said core comprising:

(a) at least two axially-spaced, parallel metal bars;

(b) a plurality of angularly-spaced metal rods interlinking said bars; and

(c) each of said bars having end portions projecting from opposite, longitudinal edges of the anode body to form joint elements for connecting one of said segments to the other in pipe-embracing relation.

2. An anode according to claim 1 wherein said anode metal is a member selected from the group consisting of aluminum, zinc, magnesium, and alloys thereof.

3. An anode according to claim 1 wherein said core is constructed of mild steel.

4. An anode according to claim 1 including electric current conductor elements connected to said core for electrically connecting the core to the pipeline.

5. An anode according to claim 1 wherein one of said end portions is offset laterally to receive the non-offset end portion of an opposed bar to form the joint therebetween.

6. A galvanic anode for cathodic protection of pipelines, comprising:

(a) a pair of semicylindrical segments adapted to embrace a pipeline, each sigment comprising:

(1) a continuous, semicylindrical body of a galvanic anode metal;

(2) A metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body;

(3) said core comprising:

(a) at least two axially-spaced, metal bars; and

(b) each of said bars having end portions projecting from opposite, longitudinal edges of the anode body to form joint elements for connecting one of said segments to the other in pipe-embracing relation.

7. A galvanic anode for cathodic protection of pipe lines, comprising:

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(a) a pair of arcuate segments adapted to embrace a pipe line, each segment comprising:

(1) a continuous, arcuate body of a galvanic anode metal;

(2) A metal core cathodic to the anode metal concentrically embedded entirely within the anode metal adjacent the inner periphery of said body;

(3) said core comprising:

(a) at least two, axially-spaced metal bars;

(b) each of said bars having end portions projecting from opposite longitudinal edges of the anode body to form joint elements for connecting one of said segments to the other in pipe-embracing relation.

8. A galvanic anode according to claim 7, and a plurality of angularly-spaced metal rods interlinking said bars.

9. An anode according to claim 7, wherein said anode metal is a member selected from the group consisting of aluminum, zinc, magnesium, and alloys thereof.

10. An anode according to claim 7, wherein said core is constructed of mild steel.

11. An anode according to claim 9, including electric current conductor elements connected to said core for electrically connecting the core to the pipeline.

12. An anode according to claim 11, wherein one of said end portions is offset laterally to receive the non-offset end portion of an opposed bar to form the joint therebetween.

13. A galvanic anode for cathodic protection of pipelines comprising:

a plurality of arcuate segments adapted to embrace a pipeline, each segment comprising:

(1) a continuous, arcuate body of a galvanic anode metal;

(2) a metal core cathodic to the anode metal concentrically and entirely embedded within the anode metal adjacent the inner periphery of said body;

(3) said core comprising:

(a) at least two, axially spaced-apart metal bars;

(b) each of said bars having end portions projecting from the opposed longitudinal edges of the said segments to form joint elements for connecting said segments to each other in pipe-embracing relation.

14. The anode according to claim 13, and at least one metal rod in each segment for interlinking said bars.

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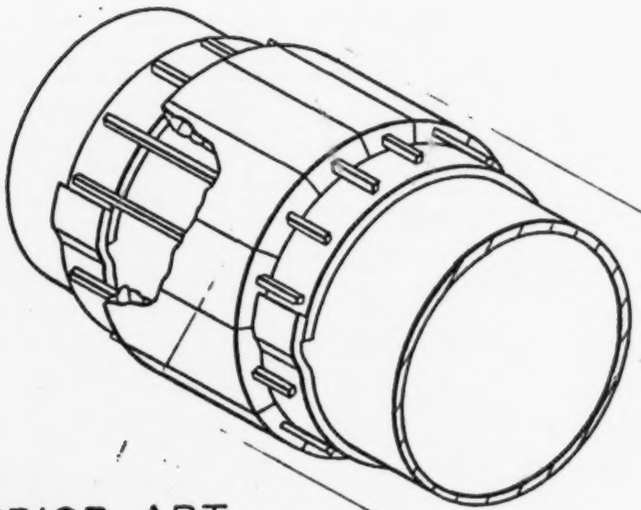
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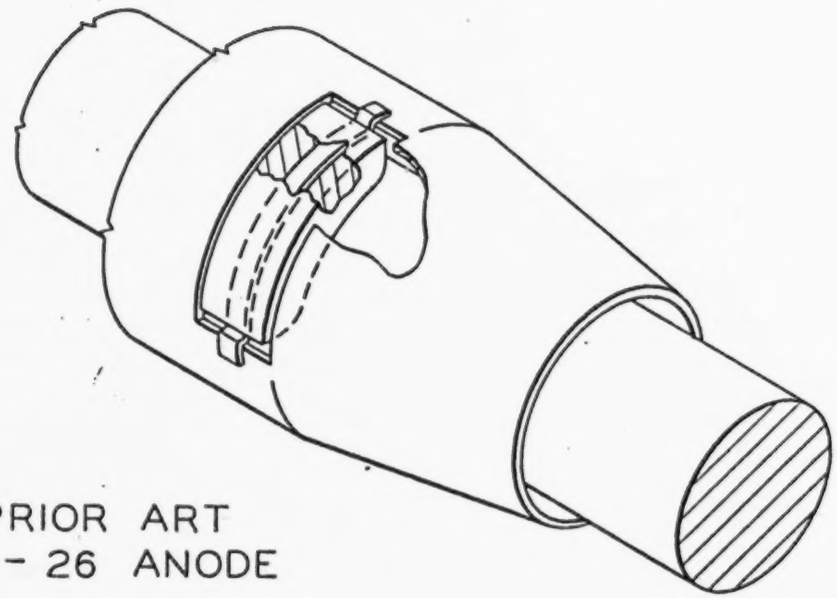
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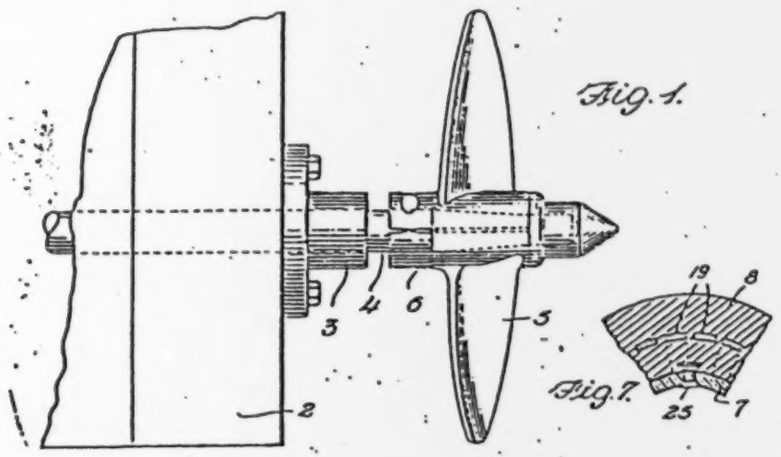


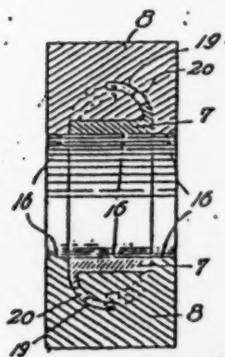
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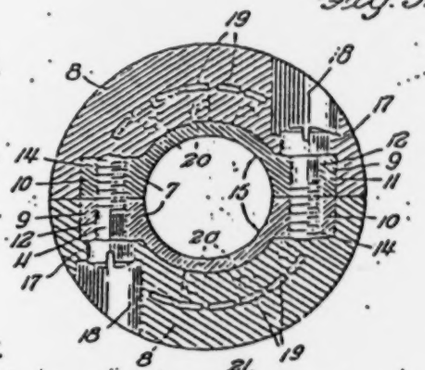
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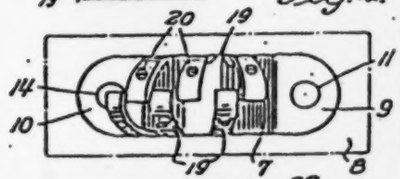
CORROSION CHECKING DEVICE

Filed July 24, 1935









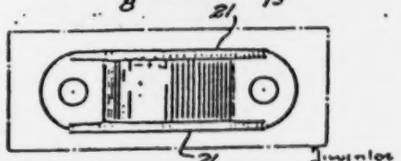
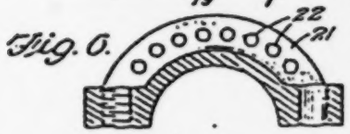


Fig. 5.



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CORROSION CHECKING DEVICE

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Application July 24, 1935, Serial No. 32,932

2 Claims. (Cl. 114—65)

The object of this invention is to prevent corrosion of boat parts such as propellers, propeller shafts, stuffing boxes, or the like, which are subject to corrosive electrolytic action, by providing a metal body in metallic circuit or contact with one or more of said parts.

A further object of this invention is to construct such metal body in the form of a sectional collar comprising a foundation of metal of substantially the same polarity as that of the metal part to which the collar is attached and anchoring the said electronegative metal to such foundation in a manner that the collar will not become loose regardless of the amount of corrosion action to which the electronegative metallic part of the collar may become subjected.

With these and other objects in view, reference will be had to the accompanying drawing, wherein:

Fig. 1 is a view in side elevation illustrating a propeller, propeller shaft, stuffing box and skeg of a boat, and with the collar comprising the invention applied to the propeller shaft,

Fig. 2 is a vertical sectional view taken through the collar longitudinally of its axis,

Fig. 3 is a vertical sectional view taken through the collar transversely of its axis,

Fig. 4 is top plan view of the core of the upper section of the collar before the same is enshrouded by the electronegative metal,

Fig. 5 is a view similar to Fig. 4 of a modified form, and

Fig. 6 is a vertical sectional view of the core section of Fig. 4.

Fig. 7 is a fragmentary detail of a modification.

In Fig. 1 of the drawing, reference numeral 2 designates the keel or keel of a boat, 3 the stuffing box, 4 the propeller shaft, 5 the propeller, all of conventional form, and 6 the collar which forms the subject matter of this invention.

The preferred form of collar is illustrated in Figs. 2 to 4 inclusive, and said collar consists of two sections, each composed of a core 7 embedded in a zinc shroud 8. The core 7 is composed of a metal having a position in the electromotive series approximating that of the part to which the collar is to be attached to substantially avoid electrolytic action between the core and the said part. Were an all zinc split collar attached to a propeller shaft or other boat part, corrosion of the zinc would soon loosen the collar so that the same would not only rattle but would virtually lose its effectiveness for the intended purpose. By employing an attaching means of the nature described, these defects are avoided.

The zinc shroud 8 may be attached to the core 7 of each section in various ways to assure its attachment through a long period in the life of the zinc, but a very effective mode of attachment is by casting the zinc 8 upon or around the core.

Each core section 7 is formed with ears 9 and 10, and screws or bolts 11 pass freely through holes 12 in the ears 9 and screw into threaded openings 14 in the ears 10, clamping the collar sections tightly upon in non-rotative relation with the propeller shaft or other of said boat parts. These screws are of a metal having substantially the same polarity in the electromotive series as the metal of the core sections 7.

The adjacent faces of the ears 9 and 10 preferably do not tightly close together, but the inner semi-circular faces 15 of the core sections tightly engage opposite faces of the propeller shaft or like boat part throughout most, if not all, of their areas. Likewise, the adjacent faces of the zinc shroud do not tightly close together; but their faces 16 like the core faces may, though not necessarily, bind upon opposite sides of the shaft or other boat part. The metal of the shroud sections 8 is counter-sunk at 17 and 18 for free passage of the heads of the screws or bolts 11 into direct binding engagement with the core ears 9.

While satisfactory results may be obtained in a degree by simply enveloping the sides and outer faces of the core sections in zinc cast thereupon, a more positive anchoring means has been devised in the nature of fins or projections on the core sections, with which the metal of the shroud sections interlock, such interlocks being unaffected by corrosion of the zinc shroud through a long period of its life.

These interlocks comprise parallel annular series of integral ears 19 formed integrally with each core section 7 and the ears of one series being bent toward and partially into the plane of the ears of the other series and fitting between the latter ears. These ears may or may not be perforated as at 20 to afford additional interlocks for the zinc which flows into such perforations during the casting operation. This lateral bending of the ears 19 offsets centrifugal throw of the zinc when the collar is attached to a rotating propeller shaft or propeller.

The modified form illustrated in Figs. 5 and 6 is substantially the same structurally as the preferred form, except that parallel uninterrupted ribs are provided on the core sections and these are perforated at 22 to function like the perforations 16 in providing interlocks for the zinc shroud.

While zinc has been specified as constituting the metal of the shrouds 8, other metal standing on the electronegative side of the electromotive series from the metal of the parts of the boat to be protected may be employed. The core sections 9 and screws 14 may be of metal standing substantially in the same position as the metal of the part to be protected, and since such parts are usually of bronze, that metal is generally the one used. Where bronze propellers are used with steel shafts, zinc is used for the shroud 8 and a metal adopted for the core sections 9 from the electromotive series as will be best suited to insure longest life of the parts subject to corrosion.

The collar 6 is preferably clamped around the propeller shaft in metallic contact with the propeller or stuffing box, according to which is to be protected, though satisfactory results are obtainable by mounting the collar on the propeller shaft away from the propeller or stuffing box. Obviously the collar may be applied to any other boat part subject to corrosion through electrolytic action between sea-water and metals of different potentials in the electromotive series.

While two forms of anchoring means have been disclosed for securing the corrosive metal to the substantially non-corrosive core sections, it will be clear that the anchoring means is susceptible to many variations.

In practice the device has been found to be very effective for the designed purpose, and while a correct theory explaining its action may not be given, it is believed that the zinc or other metal selected from the negative end of the electromotive series, becomes the negative pole in an electrolytic circuit with the metals of the propeller, propeller shaft, and stuffing box, all of which are from the positive end of the electromotive series, the sea water acting as the electrolyte. In such a circuit corrosion is confined principally, if not entirely, to the most electronegative material, and is checked to a high degree in the other metallic parts.

Obviously, the core parts 7 could be constructed of bakelite or similar non-metallic material since their purpose is to provide a non-corrosive means for attaching the corrosive shroud 8 to the propeller shaft or other marine structure part, and the screws could be of the same non-metallic material, reinforced or not, or even of non-corrosive material relatively to the metal of the shroud. Metallic circuit is established between the corrosive shroud 8 and the propeller shaft or other part to which the collar is attached by a metallic plug or conductor 23 preferably of the same metal as the said propeller shaft or other part.

The present invention makes it unnecessary to run any exposed wires between parts, particularly to get around any non-conductive material placed between the zinc or negative metal and the metal part to be protected.

What is claimed:—

1. A collar for a propeller shaft comprising two semicircular sections each having diametrically opposite ears, means associated with the ears for tightly clamping the collar sections about said propeller shaft, said collar sections each having a radial extension having a trail portion disposed at an angle to the radius of the extension, and a metal negative in the electromotive series to the metal of the propeller shaft to be protected cast upon each collar section and enclosing the exposed outer surface thereof and its radial extension, said cast sections being provided with an opening affording access to said clamping means.

2. A collar for a propeller shaft comprising two semi-circular sections each composed of a relatively non-corrosive material, means associated with said collar sections for tightly clamping the collar sections about said propeller shaft, each of said collar sections having radial extensions along the outer edge thereof, said extensions being curved or arched inwardly from the outer edges of the collar section, their ends intermeshing, and a metal negative in the electromotive series to the metal of the propeller shaft to be protected cast upon the outer exposed surface of the collar section and enclosing the said curved radial extensions, said cast section being provided with an opening affording access to said clamping means.

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